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# *Studia Geobotanica*

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**LANGUAGE** should be preferably English. Italian, German, French and Spanish are also accepted.

The **TITLE** should be informative and brief. The name(s) (given name-surname) of the author(s) should be placed below the title. References to research projects, institutional publication numbers, etc. should be placed in the Acknowledgements at the end of the main text.

**KEYWORDS**, no more than 6, in English, should be placed on the title page in alphabetical order.

**ABSTRACT**. An English abstract must be included. For non English text, the abstract must include the title (in small capitals). A summary in a second language may also be added; it should not exceed one manuscript page and is placed before the acknowledgements.

The **MAIN TEXT** should be clearly divided into sections (Introduction, Study area, Data & methods, Results). Chapter headings should be given without designations. New paragraphs should be indicated by indentation. Footnotes should be avoided.

**APPENDICES** with lists of localities, sporadic species of relevés, etc. should be placed at the end of the main text. On all points of style please consult recent copies of the journal.

**ACKNOWLEDGEMENTS** and dedications should be simply phrased and given before the references.

**REFERENCES** to articles and books should be limited to published works. Citation of references in the text: Dolcher & Pignatti (1971) or (Fukarek 1977; Clotet *et al.* 1988; Podani & Borhidi 1989).

**Citation of references**:

Malyshev L.I., 1991. *Some quantitative approaches to problems of comparative floristics*. In: Nimis P.L. & Crovello T.J. (eds.), *Quantitative approaches to phytogeography*. Kluwer Academic Publishers, Dordrecht, Boston, London, 15-33.

Poelt J., 1969. *Bestimmungschlüssel europäischer Flechten*. J. Cramer, Vaduz, 757 pp.

Trevisan R., Cappelletti E.M. & Caniato P., 1983. *Epicarp micro-characters in some European* Angelica *species*. Atti Accad. Naz. Lincei, Rend. Cl. Sci. fis., mat. e nat., 74: 77-82.

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# MALLEE COMMUNITIES ALONG ROADSIDES IN SOUTH-WESTERN AUSTRALIA

Erika PIGNATTI WIKUS [1], Giuseppe PIGNATTI [2] and Stephen D. HOPPER [3]

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**Keywords:** conservation, Eucalyptus, mallee vegetation, phytosociology, Western Australia.

**Abstract:** Vegetation with eucalypts of the mallee type along four roadside transects in the South-West of Western Australia has been studied. Mallee communities occur under dry-mediterranean climate conditions. Species composition, diversity and turnover, local endemism with particular regard to *Eucalyptus* and *Acacia* species and habitat conservation are discussed.

## Introduction

Mallee eucalypts are many-branched evergreen shrubs with woody stems of about 2-4 m height rising from prominent underground fire-resistant lignotubers. In areas with dry-mediterranean climate, where rainfall and soil conditions can only support small trees in natural vegetation, the mallee habit seems an adaptation to above ground damage, caused more often by frequent fires in ecosystems (Beadle 1981). Alternatively, the lignotuber may have arisen originally as a simple way of maximising space for access to soil, water and nutrients. Besides the mallee eucalypts many different species of the genus *Acacia* of the phyllodineous type play an important role in mallee communities (Maslin & Hopper 1982).

According to Beard (1990) in southwestern Western Australia mallee vegetation occurs mainly in the natural regions (Fig. 1) of the Wheatbelt (extent of mallee vegetation 3,596 km$^2$), Mallee Region (60,680 km$^2$) and Esperance Plains (21,410 km$^2$), developing three physiognomic types: mallee with sclerophyll understorey, mallee with patches of woodland and mallee-heath (kwongan). These regions, placed between the low-rainfall zone of the interior of Western Australia and the high-rainfall of the western and southern coasts, and therefore called Transitional Rainfall Zone (TRZ, Hopper 1979), may be regarded as species rich in relation to the other regions (Marchant 1973). The TRZ (300-800 mm annual rainfall) includes the four districts of the South-West Botanical Province, i.e. Irwin, Avon, Roe and Eyre, and is the major agricultural Wheatbelt of the southwest and part of the Goldfields, woodlands and pastoral country beyond (i.e. Beard's Southwestern Interzone). Of approximately 500 species of Western Australian eucalypts, about 225 are mallees and the above mentioned three regions are the richest in taxa, with numbers declining inland and westward (Hopper 1992). As discussed by Hnatiuk & Maslin (1988), the TRZ is the area of highest species richness for *Acacia* in Australia. There are two foci of richness, one centered on Wongan Hills and the other on Newdegate, with in excess of 100 species recorded for each centre. As with *Eucalyptus*, the numbers of *Acacia* species decline rapidly towards the arid interior and the temperate western areas.

At present conservation status of species generates concerns due to the land use in the area, where extensive farming has changed most of the native vegetation into agricultural land (Hopper 1990). Burgman (1988), who studied the design of appropriate reserves specifically for mallee vegetation in Western Australia, determined that reserves should be located at least every 15 km for the same broad formations and soil types if they are to conserve representative flora, especially rare species. Rapid geographical replacement of taxa occurs in the Western Australian mallee, and a close network of reserves is needed as a consequence.

Of particular interest in this context is the roadside vegetation, which, in a heavily cleared agricul-

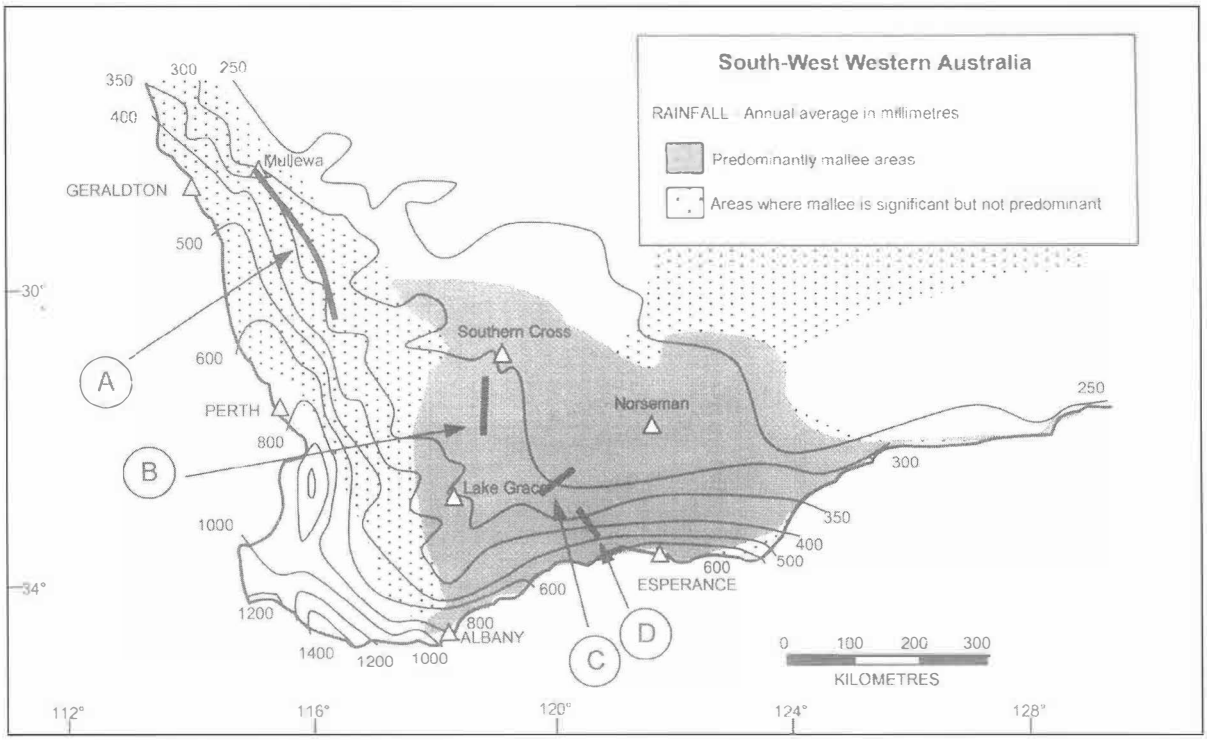


Fig. 1 - Map of the area with natural regions of mallee communities in Western Australia (Wheatbelt Region, Mallee Region, Esperance Plains).

tural land, plays an important role as a corridor or reserve for isolated pockets. Roadside vegetation in Western Australia is protected by rather strict laws which means that it should remain untouched and preserved as much as possible; farmers are obliged to safeguard and protect these vegetation strips along roadsides, around farmland and pastures. Even where the present laws are respected, it may be sometimes difficult to interpret what the natural vegetation might have been like, since much may depend on the surface extension of such areas and the intensity of human impact in the past. Nevertheless the roadside vegetation pockets are often the last remains of the former natural vegetation, so that it is indeed possible to provide a reliable analysis of the changes in species composition in strongly altered areas by human intervention.

This research aimed to study roadside vegetation types and their relation to environmental changes of mallee communities according to the phytosociological method of Braun-Blanquet in the TRZ along the direction north-west/south-east.

## Material and methods

### *Climate and soils*

The South-West of Western Australia is under the regime of winter rainfall, but annual averages vary. In the TRZ, to which the transects of the present study belong, precipitations in certain years may be extremely reduced or even lacking entirely, while in others unexpected rainfall may alter the yearly mean values. The critical climatic factor for vegetation is not the annual average rainfall but the length of the dry period and the season of the year in which it falls (Hnatiuk & Maslin 1988, Beard 1992).

The vegetation relevés are located in the extra-dry mediterranean to dry-mediterranean zone with 7-8 dry months and winter precipitation from 300-500 mm per year (Fig.1). Vegetation changes in composition from W to E (increasing aridity) and from N to S (increasing humidity). The yearly rainfall is almost constant from 338 mm (Morawa) and 356 mm (Buntine) in the North to 417 mm (Ravensthorpe) in the South. But most striking differences are the number of days with high atmospheric humidity (61-70 in the North and 112 in the South) and temperatures. Therefore the relevés are scattered along a climatic gradient from a warmer climate with longer lasting aridity in the North towards cooler and moister conditions in the South (Gentilli 1951).

The whole area is characterised by geological

uniformity with gently undulating surfaces. The landscape is largely flattened and shaped by erosion long ago. Only modest orogenic activity has taken place since the Permian. Important rivers are no longer active in the area of the transects.

The different soil types lie on archaean granites with unfolded metamorphics of the Yilgarn Block. Bedrocks of granites and gneisses are largely covered by sandy and gravelly soils overlying iron- and aluminium -rich duricrust, the latter above the pallid clay horizon. All soil types in the area are nutrient-poor for plant life. Nevertheless vegetation is interrelated with soil. On the basis of changes in soil, in general, catenary sequences of natural vegetation can be observed i.e. kwongan (scrub-heath) on sandplains, thickets on ironstone gravels, woodlands of *Eucalyptus loxophleba, Eucalyptus salmonophloia* on loams, and halophytes on saline soils. Valley soils usually are red loams. Uplands show a deeply weathered profile and are often covered with sandplain soils. The sand quantity is varying in proportion of ironstone gravels. In general, woodlands are on valley soils, kwongan is on sandplain, while mallee occupies an intermediate position between valley soils and sandplains (Beard 1976).

Southwest Western Australia has experienced no glaciation since the Permian Era. During the late Tertiary and Pleistocene environmental perturbations were most pronounced in the TRZ (Bowler 1982, Martin 1990).

*Species richness*

The entire Southwest Province of Western Australia has undergone a long and complex evolutionary history resulting in a rich angiosperm flora which can be estimated 8,000 and maybe even as high as 9,000 species. As a consequence of environmental perturbations in the TRZ during the late Tertiary and Pleistocene the flora has radiated extensively at the species level (*Acacia* about 560 species in all of Western Australia, *Eucalyptus* more than 400 species only in the Southwest Province, *Grevillea* about 200, *Melaleuca* about 150, *Hakea* and *Caladenia* about 100, etc.). The speciation process has been concentrated mainly on woody perennials (comprising all types of phanerophytes and chamaephytes). After continued improvement of floristic, genetic and phytogeographic knowledge, the number of endemics is still increasing and may be even higher than 80% (Hopper 1979). Many rare local endemic species are concentrated in the TRZ and subspecies, infraspecific variants, cryptic species complexes and hybrids are frequent there (Hopper 1992). The natural vegetation of this zone is complex due to its history.

By law countryroads in Western Australia have to have on both sides a strip of uncleared vegetation which has to be left rather undisturbed and therefore can represent natural or seminatural conditions. Roadside vegetation may not be the best example to study plant communities, but in Western Australia, especially in the Wheatbelt area, this often represents the only remnants of the natural vegetation. The possibility of aliens entering such areas can be expected, accidental fires may start more easily close to roadsides, fire-sensitive species may be destroyed after frequent fires, seedbanks impoverished, and evolution of plant communities and their normal species composition might be impeded. Human impact and grazing effects may cause further disturbance. Also extra run-off water and dust may affect plant-life along roadsides. Outside roadside strips the natural vegetation has often been completely destroyed due to agricultural and pastoral use or human settlements in the vicinity. To interpret what the natural vegetation might have been like, much depends on the surface extension of such areas and the intensity of human impact in the past. Nevertheless often it is indeed possible to provide a reliable interpretation of the natural plant life based on the actual species composition.

*Study areas and methods*

The relevés were chosen from North to South along four roadside transects rich in mallee eucalypts. Locations of the four transects are as follows (Fig. 1):

A) transect from Mullewa to Pithara: the location is between the Northern Sandplains and the Murchison Region, in the northern part of the Wheatbelt Region; the transect plots were taken along the road within a length of about 250 km, from 29.08.1994 to 01.09.1994 (Tab. 1, rels. 1 to 21 and Appendix).

B) transect from Jilbadge Rock to north of Hyden: the location is between the Wheatbelt and the Mallee regions, starting southwest of Southern Cross; distances between relevés are about 120 km; first transect plot on foothill of granite outcrop, the others along roadsides in direction of Hyden; relevés date: 11-12.09.1994 (Table 1, rels. 22 to 27 and Appendix).

C) transect from east of Lake King to Frank Hann National Park: located in the Mallee Region,

Transect plots start about 70 km east of Lake King and continue from there into Frank Hann National Park; distances from plot 28 to 32 are about 70 km; relevés date: 13-14.09.1994 (Tab. 1, rels. 28 to 32 and Appendix).

D) transect Cascade Road-Oldfield Road: the plots start along the Cascade Road and continue along the Oldfield Road; distances in between are about 80 km; relevés date: 23.09.1994 (Tab. 1, rels. 33 to 37 and Appendix)

Along the four transects 37 plots were studied according to the Braun-Blanquet method, i.e. areas were selected which were homogeneous as to species composition and physiognomy and in which the vegetation was regularly distributed over the surface. As to the extension of the relevés, it has to be mentioned that it was not always possible to have the same number of square metres, as roadside vegetation can sometimes be limited and shows rapid gradients and changes.

Regarding the usual performance of a relevé, the starting point is always the choice of a homotoneous surface, the complete list of all given species, their cover in % on the same surface and sociability (shape of growing within the selected surface, which was neglected in the statistic analysis). For statistically useful data the Braun-Blanquet's cover values scale was slightly modified according to Pignatti (1959).

In order to give an interpretation to the vegetation data, Cluster analysis (Fig. 2) and Principal Components Analysis (Fig. 3) were applied on cover values of species in the relevés, using the package MULVA (Wildi & Orloci 1996).

For the main groups of relevés obtained by cluster analysis, the life form spectrum, based on the sum of presences of every species belonging to the same growth form, was calculated. Life forms are "the architecture and shape" (germ.: *Bauplan* and *Gestalt*) species have adopted during the course of evolution to be able to survive best during the most critical periods. In a mediterranean type climate it is the summer drought species have to cope with. The life form system according to Raunkiaer is apt and quite sufficient for European parameters but should have some extension of new forms for other continents and climates (Box 1981). In Western Australia several particular growth forms such as grasstrees, stiltplants, species with lignotubers etc. occur which do not exist in Europe. For the transects dealt with in this paper we used only a slightly enlarged system according to Raunkiaer and distinguished the following categories:

PH = phanerophytes, i.e. tall trees (PH scap), tall shrubs (PH caesp);
PHc = woody climbers;
PHm = eucalypts of the mallee type;
NPH = nanophanerophytes, i.e. small shrubs more or less up to 1-1,5 meters high);
CH = chamaephytes, i.e. dwarfshrubs, lignified creeping and cushion plants;
H = hemicryptophytes, i.e. perennial herbs;
G = geophytes, i.e. perennial species with bulbs, rhizomes, tubers or corms;
T = therophytes, i.e. annuals comprising aliens.

**Results**

The classification of the 37 vegetation relevés using the euclidean distance algorithm and minimum variance clustering method is shown in Fig. 2. On the cluster diagram three main groups of relevés at a distance of 1.21 can be traced: group 1 includes the 21 relevés of transect A (Mullewa-Pithara) plus the first three of transect B (Southern Cross-Jilbadge Rock); group 2 is composed by the remnant relevés of transect B and all those of transect C (East of Lake King-Frank Hann NP); group 3 is composed by the relevés of transect D (Cascade-Oldfield Rd.).

Ordination of relevés by Principal Components Analysis is shown in Fig. 3 (12% of total variance explained). The three groups of relevés are well distinct by the projection of the two first components: group 1 on top of the left side of the diagram, groups 2 and 3 on the bottom of this, with transect D relevés on the highest values of the PCA first axis.

The results of this statistic analysis, with sequence following the cluster analysis of relevés and species ordered in subjective way in order to give emphasis to *Eucalyptus, Acacia* and most discriminating taxa, is shown in Tab. 1.

51 families are represented by 139 genera and over 373 species (742 occurrences: with several subspecies and varieties; 2 new species have been discovered (*Acacia* sp. nov. in transect A, rel. 17 and *Calectasia* sp. nov., a stilt plant, in transect D, rel. 37). (Table 1, see Appendix).

The participation of the most frequent families and the genus *Acacia* with the observed species number in the four transects is shown in Tab. 2.

Despite the high number of eucalypts recorded (46 species or subspecies), there is a certain number of species with relatively high frequencies (20-60%) in the three main clusters: *E. loxophleba, E. kochii*

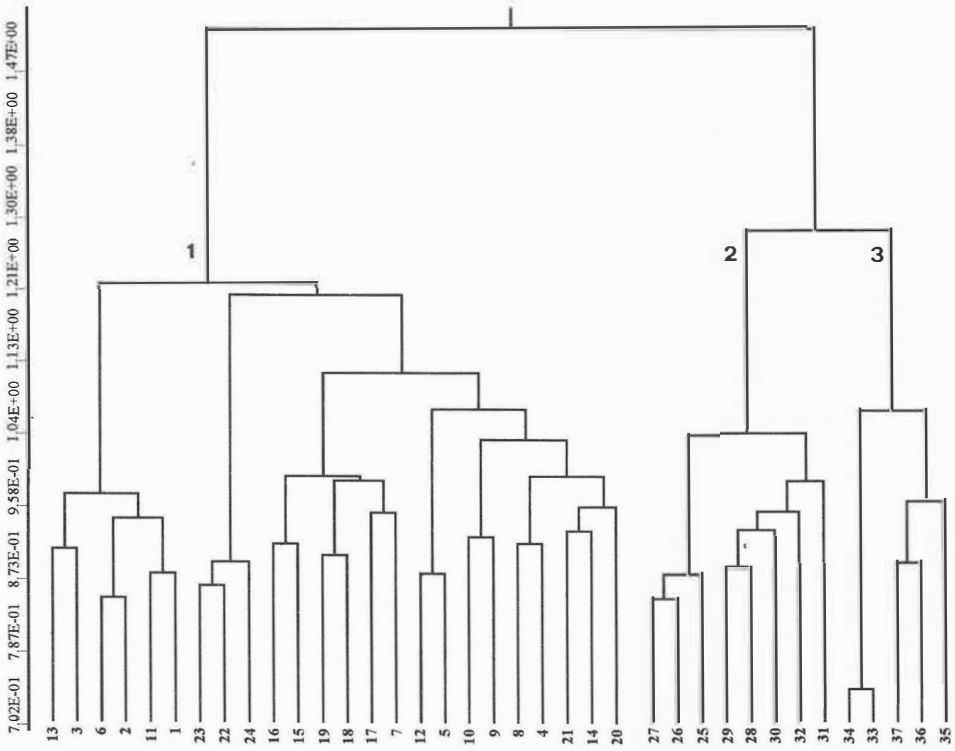


Fig. 2 - Cluster analysis dendrogram with the three groups of relevés (1-3).

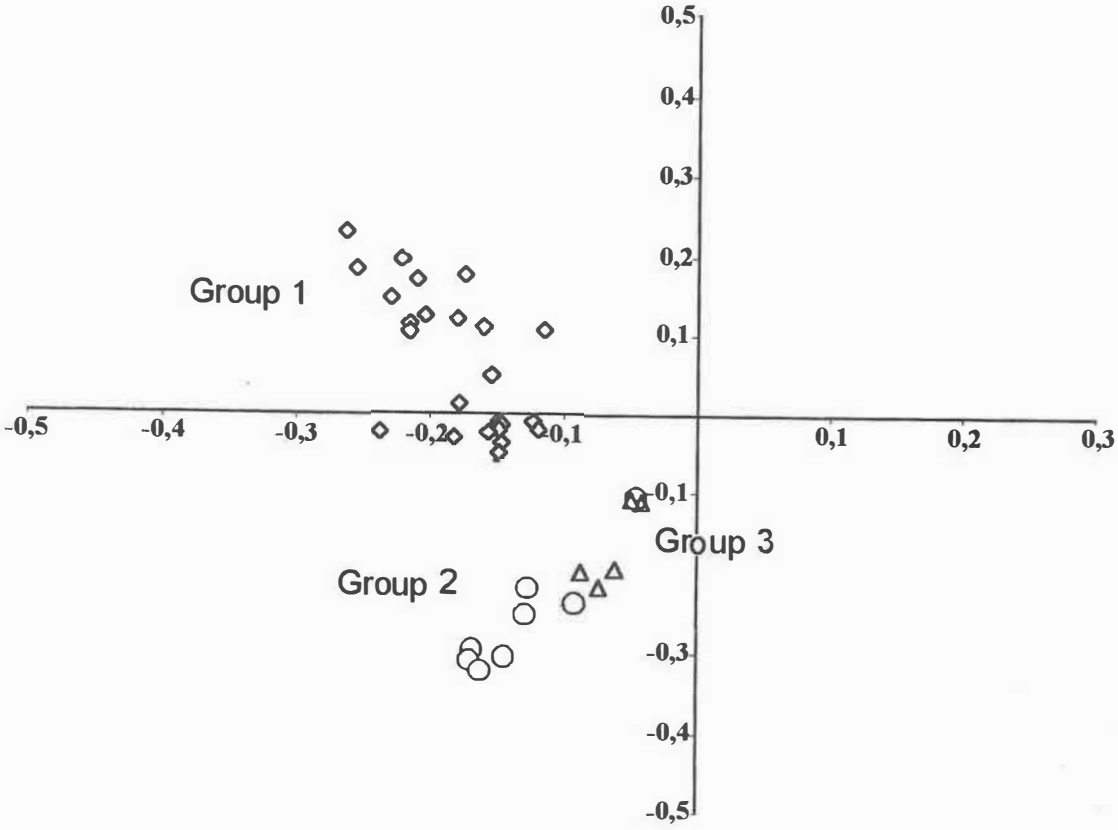


Fig. 3 - PCA with ordination of relevés.

Tab. 1 - Transect relevés with cluster groups A-D.

| Number of relevé | 13 | 3 | 6 | 2 | 11 | 1 | 23 | 22 | 24 | 16 | 15 | 19 | 18 | 17 | 7 | 12 | 5 | 10 | 9 | 8 | 4 | 21 | 14 | 20 | 27 | 26 | 25 | 28 | 30 | 32 | 31 | 34 | 19 | 33 | 37 | 36 | 35 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mallee (surface cover in %) | 40 | 30 | 20 | 0 | 0 | 0 | 40 | 10 | 60 | 30 | 30 | 25 | 40 | 20 | 70 | 40 | 5 | 30 | 50 | 80 | 30 | 30 | 35 | 30 | 30 | 30 | 30 | 20 | 30 | 20 | 70 | 60 | 0 | 30 | 30 | 70 | 20 | |
| Kwongan (surface cover in %) | 0 | 40 | 0 | 60 | 10 | 40 | 30 | 30 | 20 | 30 | 10 | 30 | 50 | 50 | 40 | 0 | 40 | 20 | 10 | 30 | 20 | 10 | 30 | 50 | 60 | 70 | 60 | 70 | 60 | 60 | 40 | 50 | 60 | 60 | 50 | 50 | 50 | |
| Herbs (surface cover in %) | 20 | 15 | 30 | 40 | 85 | 30 | 2 | 10 | 5 | 2 | 24 | 15 | 1 | 5 | 1 | 60 | 95 | 30 | 70 | 5 | 3 | 80 | 20 | 10 | 0 | 0 | 0 | 1 | 5 | 1 | 2 | 0 | 0 | 30 | 35 | 0 | 2 | |
| Species number | 19 | 26 | 11 | 22 | 16 | 14 | 15 | 31 | 25 | 28 | 24 | 32 | 24 | 25 | 20 | 13 | 11 | 12 | 27 | 27 | 25 | 49 | 20 | 36 | 23 | 27 | 32 | 28 | 23 | 21 | 22 | 19 | 19 | 28 | 25 | 25 | 23 | |
| Surface ($m^2$) | 50 | 50 | 15 | 50 | 25 | 20 | 200 | 200 | 100 | 50 | 50 | 50 | 50 | 50 | 50 | 25 | 25 | 50 | 50 | 50 | 40 | 400 | 25 | 50 | 150 | 200 | 200 | 100 | 50 | 100 | 50 | 100 | 100 | 100 | 100 | 100 | 100 | |
| Cluster group | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | Freq. |
| Transect | A | A | A | A | A | A | B | B | B | A | A | A | A | A | A | A | A | A | A | A | A | A | A | A | B | B | B | C | C | C | C | D | D | D | D | D | D | |
| Eucalyptus loxophleba | + | 2 | 3 | 4 | 4 | 3 | | 1 | | | | | | | | | | + | + | | | + | + | | | | | | | | | | | | | | | 11 |
| Eucalyptus kochii subsp. kochii | | | | | | | | | | | | 1 | + | 1 | | 2 | 2 | r | | | | | | + | | | | | | | | | | | | | | 7 |
| Eucalyptus subangusta subsp. pusilla | 2 | 2 | | | | | | | | | | | | | 1 | 1 | | | | | | | | 1 | | | | | | | | | | | | | | 5 |
| Eucalyptus salmonophloia | | | | | | | 1 | 1 | | | | | | | | | | 2 | | | | 1 | | | | | | | | | | | | | | | | 4 |
| Eucalyptus leptopoda | | | | | | | | | | + | + | | | | | | | | | | + | | 2 | | | | | | | | | | | | | | | 4 |
| Eucalyptus oldfieldii | | | | | | | | | | | | + | | | 1 | | | | | 3 | | | | | + | 1 | | | | | | | | | | | | 5 |
| Eucalyptus wandoo | | | | | | | + | + | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 |
| Eucalyptus salubris | | | | | | | 2 | | 1 | | | | | | | | | | | | | + | | | | | | | | | | | | | | | | 3 |
| Eucalyptus eudesmioides | | | | | | | | | | 1 | + | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | 3 |
| Eucalyptus erythronema var. marginata | | | | | | | | | | | | + | | | | | | | | | | + | | 1 | | | | | | | | | | | | | | 3 |
| Eucalyptus pyriformis | | | | | | | | | | | | + | 3 | | | | | | | | | | | | | | | | | | | | | | | | | 2 |
| Eucalyptus eremophila subsp. eremophila | | | | | | | | | 2 | | | | | | | | | | | | | | | | 1 | + | 1 | | | | | | | | | | | 4 |
| Eucalyptus kochii subsp. plenissima | | | | | | | | | + | | | | | | | | | | | | | | | | | | + | | | | | | | | | | | 2 |
| Eucalyptus platycorys | | | | | | | | | | | | | | | | | | | | | | | | | + | | + | | | | | | | | | | | 2 |
| Eucalyptus luteola | | | | | | | | | | | | | | | | | | | | | | | | | | + | | 2 | | | | | | | | | | 2 |
| Eucalyptus densa subsp. densa | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | + | | 1 | | | | | | 3 |
| Eucalyptus perangusta | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | + | | + | | | | | | 3 |
| Eucalyptus grossa | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | + | | | | | | 2 |
| Eucalyptus conglobata | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | | | + | 1 | | | | 3 |
| Eucalyptus leptocalyx | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | | | + | + | | | | 3 |
| Eucalyptus tetragona | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | + | | 1 | 3 |
| Eucalyptus flocktoniae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | + | | + | | | | 3 |
| Eucalyptus cylindrocarpa | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | + | | | 2 |
| Eucalyptus uncinata | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | 1 | + | | + | 4 |
| Eucalyptus phaenophylla subsp. interjacens | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 2 | 1 | | | 3 |
| Eucalyptus eremophila s.str. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | | | | 2 |
| Eucalyptus platypus | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | + | | | | 2 |
| Eucalyptus kessellii subsp. kessellii | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | 2 | | 2 |
| Eucalyptus sheatiana | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Eucalyptus aff. eremophila | | | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Eucalyptus rigidula | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Eucalyptus ebbanoensis | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | 1 |
| Eucalyptus ewartiana | | | | | | | | | | | | | | | | | | | 3 | | | | | | | | | | | | | | | | | | | 1 |
| Eucalyptus stowardii | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | | | | 1 |
| Eucalyptus diminuta | | | | | | | | | | | | | | | | | | | | | | | | + | | | | | | | | | | | | | | 1 |
| Eucalyptus phaenophylla subsp. phaenophylla | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | | | | | 1 |
| Eucalyptus pileata | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | 1 |
| Eucalyptus obesa | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | | | | | 1 |
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| Eucalyptus stoatei | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | | | 1 |
| Eucalyptus suggrandis subsp. suggrandis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | | | 1 |
| Eucalyptus forrestiana | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | | | | 1 |
| Eucalyptus tetraptera | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | 1 |
| Eucalyptus aff. conglobata | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| Eucalyptus tumida | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | 1 |
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| Acacia acuminata | + | + | + | + | | | | | | | | | | | | | 1 | | + | 2 | 1 | + | + | + | | | | | | | | | | | | | | 11 |
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| Acacia anthochaera | | + | | | | | | | | | | | | | | 1 | | | + | + | | | | | | | | | | | | | | | | | | 4 |
| Acacia neurophylla subsp. erugata | | | | | | | | | | + | + | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | 3 |
| Acacia longispinea | | | | | | | | | | | | | | + | | | | | + | + | | | | | | | | | | | | | | | | | | 3 |
| Acacia aff. anthochaera | + | | | | | | | | | | | | | | | | | + | | | | | | | | | | | | | | | | | | | | 2 |
| Acacia coolgardiensis subsp. coolgardiensis | 1 | | | | | | | | | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | | | 2 |
| Acacia microbotrya var. borealis | | | 1 | | | | | | | | | | | | | | | | | | + | | | | | | | | | | | | | | | | | 2 |
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| Acacia aulacophylla | | | | | | | | | | | | | | | + | | | | | | | + | | | | | | | | | | | | | | | | 2 |
| Acacia hemiteles | | | | | | | 1 | + | + | | | | | | | | | | | | | | | 1 | | | | + | + | | | | | | | | | 6 |
| Acacia yorkrakinensis subsp. acrita | | | | | | | | | + | | | | 1 | | | | | | | | | | | | + | | + | | | | | | | | | | | 4 |
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| Schoenus pleiostemoneus | | | | | | | | | | | + | + | + | | | | | | | | | | | | | | | | | | | | | | | | | 3 |
| Hakea coriacea | | | | | | | | | | | | | 1 | | + | | | | | | + | | | + | | | | | | | | | | | | | | 4 |
| Hakea sulcata | | | | | | | | | | | + | | | + | | | | | | | | | | | | | | | | | | | | | | | | 2 |
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| Conothamnus aureus | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | + | + | + | | | | | 4 |
| Leptomeria spinosa | | | | | | | | | | | | | | | | | | | | | | | | | | + | | + | | + | 1 | 1 | | | | 5 |
| Melaleuca calycina | | | | | | | | | | | | | | | | | | | | | | | + | | | | | | | | + | + | | | | 3 |
| Gastrolobium spinosum | | | | | | | | | | | | | | | | | | | | | | | + | + | + | | + | 1 | | | | + | | | + | 7 |
| Verticordia chrysantha | | | | | | | | | | | | | | | | | | | | | | | | + | + | | + | + | + | | | | + | | | 6 |
| Leptospermum erubescens | | | | | | | | | | | | | | | | | | | | | | | | | 1 | + | | 1 | | | | | | + | + | 5 |
| Calytrix lechenaultii | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | | | + | | + | | | 3 |
| Logania buxifolia | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | | | | | | + | | 2 |
| Cassytha racemosa | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | 1 | | | 1 | | 3 |
| Hakea nitida | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | | | | | + | 2 |
| Grevillea pauciflora | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | + | 1 | + | + | 5 |
| Comesperma spinosum | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | + | + | + | | 4 |
| Hibbertia cfr. rupicola | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | + | + | 3 |
| Grevillea pectinata | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | 1 | | | | 2 |
| Calothamnus gracilis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | 1 | | 2 |
| Isopogon polycephalus | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | + | + | | 2 |
| Lepidosperma tenue | | | | | | | | | | | | | | | | | | | | + | | | | | | | | | | | | | | + | + | 3 |
| Banksia dryandroides | | | | | | | | | | + | | | | | | | | | | | | | | | | | | | | | | | | | + | 2 |
| Banksia media | | | | | | | | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 2 |
| Boronia albida | | | | | | | | | | | | | | | | | | | | | | + | | | | | | | | | | | | + | | 2 |

subsp. *kochii* and *E. subangusta* subsp. *pusilla* for group 1, *E. oldfieldii* and *E. eremophila* subsp. *eremophila* for the groups 1 and 2, *E. uncinata* and *E. phaenophylla* subsp. *interjacens* for group 3. *Acacia acuminata* and *A. acuaria* reach the highest frequencies in group 1, *A. hemiteles*, *A. yorkrakinensis* subsp. *acrita* and *A. colletioides* in groups 1 and 2.

In the herb layer the highest occurrences (= frequencies) in group 1 were reached by *Waitzia acuminata, Thysanotus manglesianus, Trachymene pilosa, Podolepis capillaris, Hyalospermum glutinosum, Stipa compressa,* now *Austrostipa compressa, Erodium cygnorum*, nearly all with low cover values. Also some aliens like *Avena barbata, Hypochoeris glabra, Arctotheca calendula* appear frequently. Some species have a distinct distribution in groups 1 and 2 (*Dianella revoluta, Melaleuca cardiophylla, Allocasuarina campestris, Grevillea paradoxa, Santalum acuminatum, Isopogon scabriusculus* etc.), only 4-5 species are distributed in all groups (*Melaleuca uncinata, Thryptomene tenella, Melaleuca scabra* s.l., *Phebalium tuberculatum, Phebalium drummondii*). Some species distinguish group 2 (*Allocasuarina corniculata, Hakea meisneriana, Malleostemon roseum, Conothamnus aureus*) and 3 (*Grevillea pauciflora, Comesperma spinosum, Hibbertia* cfr. *rupicola*).

Tab. 2 - Most frequent taxa occurring in the relevés.

| Taxon | Specie number |
|---|---|
| *Myrtaceae* | 85 |
| *Proteaceae* | 52 |
| *Acacia* | 37 |
| *Asteraceae* | 26 |
| *Poaceae* | 19 |
| *Fabaceae* | 9 |
| *Goodeniaceae* | 8 |
| *Dilleniaceae* | 8 |
| *Liliaceae* s.l. | 8 |
| *Chenopodiaceae* | 7 |
| *Rutaceae* | 7 |
| *Santalaceae* | 7 |
| *Epacridaceae* | 7 |
| *Restionaceae* | 7 |

Tab. 3 - Percentage of life forms within the three groups of relevés.

| Life Form | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| **PHm** | 14.4 | 15.8 | 26.9 |
| **PHc** | 0 | 1 | 3.7 |
| **NPH** | 30.7 | 53 | 41.7 |
| **CH** | 15.1 | 25.8 | 22.2 |
| **H** | 2.5 | 0.5 | 0 |
| **G** | 8.2 | 3.5 | 5.6 |
| **T** | 29.1 | 1.5 | 0 |

The life form spectra in the three main relevés groups are shown in Tab. 3. It is noteworthy:

1) the increasing percentages in mallee eucalypts from group 1 to group 3 (from 14.4 to 26.9%);
2) the relevant participation of chamaephytes (15.1 to 25,8%);
3) the high percentage of nanophanerophytes in group 2 (53%);
4) the high percentage of therophytes (mostly aliens) in group 1 (29.1%).

## Discussion

### *Vegetation patterns in the transects*

Although the surfaces of plots in the four transects can often be considered not sufficiently big and therefore under the minimum area along the geographical gradient NW-SE, where mallee communities have their highest concentration, the general trend emerging from vegetation plots shows a clear distinction between relevés of the north-western and south-eastern part. As cluster and scatter diagrams reveal, the north-western group of relevés is composed by data collected in transect A and the first three relevés of transect B, whereas, on the contrary, the remaining relevés of the last transect and those of transects C and D form the second group of relevés (Tab. 1). This division is not surprising, because along a line in NE-SW direction between Southern Cross and Hyden, the border of the two natural regions is placed, i.e. between the Wheatbelt in the north and the Mallee Region in the south, characterizing the TRZ. As pointed out by Beard (1992), there are differences in climate and soil between the Wheatbelt Region vs. Mallee Region, which cause a remarkable change within the catenary sequence in the two areas. In the Wheatbelt Region the mallee which occurs on duplex soil comprises a minor portion of the catena which is dominated by woodland and kwongan. In the Mallee Region, however, mallee eucalypts are dominant in the topographic sequence, extending along the whole slope and surpassing woodlands and kwongan, which occupy respectively the bottom and the top of the slopes. This fact is explained by the total rainfall which is higher in the western areas and creates more favourable soil moisture conditions.

The difference in habitat between the two natural regions could explain basically the distinct vegetation features in the groups of relevés, as underli-

ned in the multivariate analysis (Fig. 3). In fact we can assume that along the transects a climate gradient could also be responsible for vegetation change: mean temperatures decline in a N-S and W-E direction, whereas total rainfall is more or less constant in the Wheatbelt, but increases in the Mallee Region in NW-SE direction. The better moisture conditions could explain the ordination of relevés on the first PCA axis, which shows, from left to right, both groups of relevés, the sequence from vegetation data carried out in dryer conditions (Mullewa area and Hyden area) to those under moister conditions (Dalwallinu area, Cascade-Olfield Rd area). Basically, PCA axis 1 could be interpreted as related to moisture (increasing moisture with higher x values) and PCA axis 2 to temperature (increasing temperature with higher y values). This may explain the higher occurrences of therophytes (species adapted to dryer conditions) in the northern relevés (Cluster group 1, Tab. 1).

Although climatic and soil factors seem to play an important role in geographical replacement of vegetation in the mallee communities, biogeographical considerations should also be considered. *Eucalyptus subangusta* subsp. *pusilla*, *Waitzia acuminata* (distribution area: Austin, Avon, Coolgardie, Irwin Botanical Districts) and several other taxa can be considered as indicator species for the north western mallee communities. Others like *Grevillea pauciflora, Melaleuca calycina* etc. seem to be more frequent in the southern distribution area of mallee communities. Aliens show highest frequencies in the relevés of the Wheatbelt Region, where land clearing for agricultural purpose was most intense. The collected data show a geographical replacement of species and explain the main characteristics of the Natural Regions, as described on a different basis in literature (Beard 1992). In addition they point out the potential danger of diffusion of aliens and reduction of the corridor role of native vegetation remnants.

*The mallee species of the transects*

Present-day occurrences of mallee communities are closely related to edaphic factors dependent on rainfall, substrate and landform. Many mallees occur over a wide climatic range, and on different soil types as extremes of this climatic range (Hill 1990). For example, *Eu. tetragona* (now largely *pruinocarpa*) and *Eu. eudesmioides* can occur on lateritic sandplains but also on calcareous coastal dunes. Mallee communities with kwongan vegetation in the understorey are frequent in the SW on sandplains and species-rich, becoming less so in dryer areas (Hill 1990).

Most mallee stands contain several eucalypt species varying mostly from 2-8 in the four transects. The most significant development of mallee eucalypts in terms of number and species diversity occurs in southwestern Western Australia where extensive speciation and radiation have taken place. The mallee habit may have arisen early in history or at a later time; some species appear to have secondarily lost the mallee habit and returned to tree forms; several moort, marlock and mallet species are of this type (Hill 1990).

The mallees of the transects are all sclerophyllous shrubs of 1-5 m height, adapted to fires, seasonal drought and extreme nutrient-poor soils. Evidently a high speciation rate occurred in eucalypts predisposed to such conditions (Beard 1992).

*The Acacia species of the transects*

Acacias, with 950 species presently recognised, form the largest group of vascular plants in Australia (Fig. 4A). 560 species occur in Western Australia (Hnatiuk & Maslin 1988, Maslin 1995). The southwest region is most distinct regarding the distribution of *Acacia* species and shows the highest species richness. Species distribution maps of Fig. 4 demonstrate that the area where transect A is situated, is close to the edge of highest species richness of *Acacia* within Australia and the world (Maslin & Pedey 1982). One third of the taxa of the region are present in the transect relevés. Although they represent all widerspread and rather common species within the area, they are a significant sample of northern Wheatbelt taxa of *Acacia*. While *A. acuminata* and *A. microbotrya* are widespread over the entire Wheatbelt, *A. coolgardiensis*, *A. longispinea* and *A. anthochaera* are restricted to the northern part. Very few extend their distribution area to the East (*A. tetragonophylla*). All the rest are basically endemic to the area.

Most of the acacias listed in the four transects belong to the subgenus *Phyllodineae*. This group has undergone extraordinary diversification within Australia (Maslin 1995, see Fig. 4B) and can become an important element of the landscape, particularly in arid and semiarid areas (Maslin & Pedley 1982). About half of the species listed in transect A belong to the *Phyllodineae*, the other half to *Juliflorae* and *Plurinerves*; none of section *Pulchellae* was listed. (Sect. *Phyllodineae* has 1-nerved *phyllodes* and spicate inflorescences, sects. *Juliflorae* and

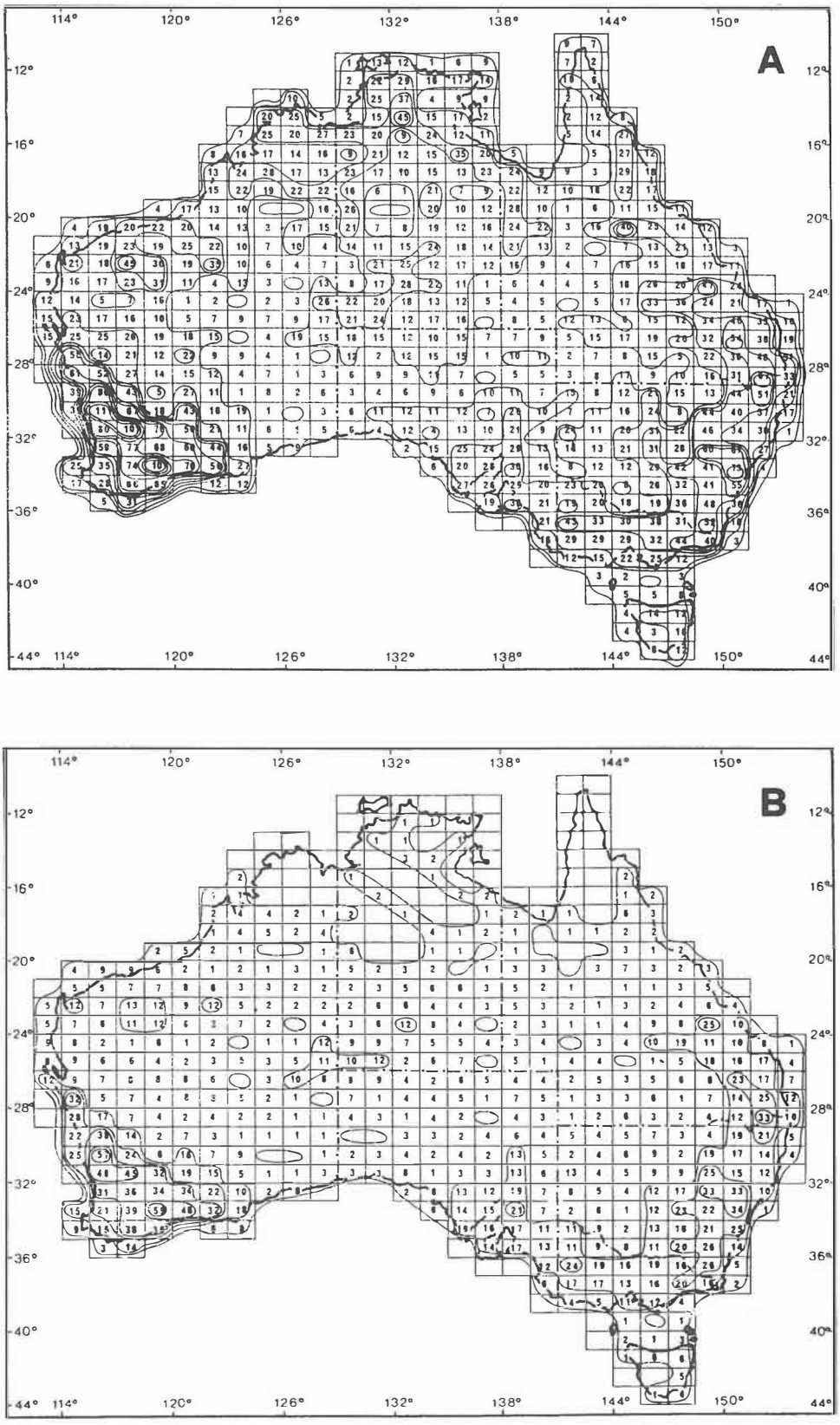


Fig. 4 - Species richness in Australia of the genus *Acacia* (Fig. A), based on 840 species, and of its section *Phyllodineae* (Fig. B); 1°x1.5° grids (after Maslin & Hnatiuk 1988 and Maslin & Hnatiuk 1995, respectively).

*Plurinerves* have multinerved phyllodes and flowers are in globules.)

*Acacias* clearly present close correlation to edaphic factors (Maslin & Hnatiuk 1983). *A. hemiteles, A. microbotrya* and *A. anthochaera* (all sect. *Phyllodineae*) grow on heavy soils (i.e. loam and clay), *Acacia coolgardiensis, A. neurophylla, A. fragilis, A. longispinea*, and *A. multispicata* (sects. Plurinerves and Juliflorae) grow on permeable soils (i.e. lighter, gravelly sands). Anomalous is here *A. acuminata* (from the Juliflorae group) on heavier soils. Acacias generally do not favour very salty areas (Maslin & Pedley 1982).

For the geographic pattering of species distribution in acacias, precipitation (i.e. average quantity and duration of precipitation) seems more important than temperature (Hnatiuk & Maslin 1988).

Different to transect A, cover values of *Acacia* species in transect B are not significant, besides these stands show relevés with different species combination on a mixture of soil types. All acacias are widespread species, some of them towards the end of the range (*A. hemiteles, A. yorkrakinensis, A. colletioides*). Some of these species often occur around granite outcrops and have greater water consumption. Those species are common and generally widespread in the area; only *A. chrysocephala* is linked to the southern Wheatbelt area.

Transect C shows within the relevés a rather high percentage of kwongan species, but acacias (except in rel. 4) are not relevant. This speaks for the fact that in general acacias are not well represented in kwongan. From 50 acacias gazetted for the area grid only 2% are present in the plots. Species numbers decline rapidly away from centres of richness; grid 276, Newdegate, shows 101 species in the south (Hnatiuk & Maslin 1988, Fig. 4).

Acacias in transect D are lacking or with insignificant cover values (rel. 33-37). Plants are small, shrubby and endemic with rather restricted geographic ranges confined to the southern Wheatbelt and the adjacent Goldfields.

*Acacia* pollen was found in early Miocene. The extensive speciation of the genus may thus have occurred at a time when variations in moisture regime were the pre-eminent forces in the taxonomic and ecological sorting of taxa. Climatic oscillations during the Pleistocene would have accentuated such forces (Maslin & Hopper 1982).

*Conservation issues*

As pointed out by Hopper (1990) Western Australia has the greatest diversity and most extensive communities of mallee eucalypts on the continent. In Western Australia about 500 species of eucalypts occur of which about 225 are mallees, 86 species are indicated as rare (following the IUCN categories), 44 as vulnerable, 3 as endangered and 44 as poorly known. This incredible biodiversity is concentrated mainly in southern coastal regions.

Mallee eucalypts in southern Western Australia have an extensive distribution from isolated patches in the high rainfall forests and along the extreme south western coast, through the heavily cleared Wheatbelt out into the western deserts (the Great Victoria Desert is especially rich in mallee communities). Those taxa most endangered consequently are found where destruction of native vegetation has been greatest, i.e. in the Wheatbelt. In the 1990s, 31 (all mallees) were given special legal protection by being declarated as Rare Flora under provisions of the Wildlife Conservation Act. Of these 31, 12 are yet to be formally described. 22 are localised endemics of different parts of the Wheatbelt. Most occupy such small areas that populations are threatened by accidental distruction (bulldozing, ignorance).

Consequently a considerable effort is made by CALM staff to ensure that landowners and the potential users of bulldozers are informed and shown the location of populations. In some cases, populations are threatened by major activities destructive of native vegetation such as agricultural land clearings (e.g. *Eucalyptus goniantha* subsp. *goniantha*) or open-cut mining (e.g. *Eu. suberea, Eu. lateriticola*).

In all four transects local endemics, species with small distribution ranges, endangered species, geographical species variation, interpopulational differentiation and polymorphism within several genera have been observed and the necessity to preserve these areas seems obvious. Moreover at least two transects (B and D) are far from Nature Reserves and National Parks and in these cases along roadsides they are nearly the only strips of natural or semi-natural vegetation left in the area.

## Conclusions

Mallee communities and related vegetation types (woodland and kwongan) have been studied along four roadside transects in the Southwest of Western Australia according to the Braun-Blanquet phytosociological method. The 37 relevés affirm a high species turnover (gamma diversity) already within short distances and many eucalypts of the mallee type and wattles of the phyllodineous growth

form show patchy distribution. No single species is present in all 37 relevés. 114 of 742 species listed occur only once, among them 11 species of *Eucalyptus* and 20 species of *Acacia*. The genera *Eucalyptus* (63) and *Acacia* (39) are the most frequent ones, followed in decreasing order by the genera *Melaleuca, Hakea, Grevillea, Verticordia*. The number of *Proteacae* increases from north-west to south-east in the southernmost transects. The number of *Acacia* species is higher in the northern Wheatbelt area transect than in the southernmost transect. Therophytes (mostly everlastings and aliens) are frequent in the northern Wheatbelt area transect and nearly absent in the southernmost transect.

In spite of the fact that several relevés are below the minimum surface due to the particular environmental conditions along roadsides, the Braun-Blanquet method has shown its applicability and practical use also in these vegetation types which yet had not been described by phytosociological approaches. The groups of relevés resulting from the statistical analysis are related to environmental changes (soil, rainfall and habitat) and show that vegetation maintains its ecological value also under disturbed conditions.

In a landscape unglaciated for millions of years like Western Australia with particular distribution patterns of species and rather small population sizes, the conservation of ecosystems with rare environment and species combination must also take into consideration the preservation of areas outside specifically designated Nature Reserves and National Parks. This means that future management of specifically small and isolated populations which may occur in limited areas like roadside vegetation is required.

## Appendix

**Localities and sporadically occurring species of the relevés: Rel. 1**: 15 km north of Mullewa. *Ptilotus divaricatus* (+), *Sisymbrium officinale* (+), *Thryptomene tuberculata* (+). **Rel. 2:** 7 km south of Mullewa. *Halgania preissii* (+), *Maireana carnosa* (+), *Medicago minima* (+), *Pimelea* cfr. *argentea* (+), *Ptilotus gaudichaudii* (+), *Stipa* cfr. *hirsuta* (+), *Waitzia aurea* (+). **Rel. 3:** 18 km south of Mullewa. *Caesia parviflora* (+), *Cheiranthera filifolia* (+), *Pittosporum phyllyreoides* (+), *Stenopetalum filifolium* (+). **Rel. 4:** Wilroy, 20 km south of Mullewa. *Calytrix flavescens* (+), *Cyatochaeta avenacea* (+), *Grevillea phanerophlebia* (+), *Onychosepalum laxiflorum* (+). **Rel. 5:** 40 km south of Mullewa. *Ehrharta longiflora* (+), *Hordeum leporinum* (+), *Lolium rigidum* (+), *Sonchus oleraceus* (+). **Rel. 6:** 46 km south of Mullewa. *Allocasuarina lehmanniana* (1), *Atriplex erilifolia* (+), *Codonocarpus cotinifolius* (+), *Lamarckia aurea* (+). **Rel. 7:** 49 km south of Mullewa. *Dampiera haemathotricha* (+), *Westringia rigida* (+). **Rel. 8:** 58 km south of Mullewa. *Bellida graminea* (+), *Chamaelaucium ciliatum* (+), *Eriostemon tomentellus* (+), *Baeckea* sp. (1), *Drummondita* sp. (+). **Rel. 9:** 65 km south of Mullewa. *Gnaphalium indutum* (+), *Gnephosis eriocephala* (+), *Rhagodia acicularis* (+), *Sonchus asper* (+). **Rel. 10:** 21 km to Morawa. *Cassia eremophila* (+), *Dodonaea larraeoides* (+), *Eremaea denticulata* (+). **Rel. 11:** 5 km south of Morawa. *Acanthocarpus preissii* (+), *Atriplex prostrata* (1), *Corynotheca macrantha* (+). **Rel. 12:** 25 km south of Morawa. *Aristida stipoides* (+), *Ptilotus lividus* (+), *Stylobasium australe* (+), *Vulpia myuros* (+). **Rel. 13:** 30 km south of Morawa. *Gilruthia osbornei* (+), *Pentaschistis airoides* (+), *Ptilotus exaltatus* (+), *Daviesia* sp. (+). **Rel. 14:** 5 km south of Perenjori. *Hibbertia subvaginata* (+), *Lolium temulentum* (+), *Stipa elegantissima* (1), *Stylidium elongatum* (+), *Tragus australianus* (+). **Rel. 15:** 15 km south of Perenjori. *Actinostrobus psammophila* (+), *Danthonia setacea* (+), *Verticordia grandiflora* (+). **Rel. 16:** 30 km south of Perenjori. *Cyanostegia angustifolia* (+), *Hybanthus floribundus* (+), *Thomasia purpurea* (+), *Verticordia* cfr. *monadelpha* (1), *Verticordia picta* (+), *Beaufortia* sp. (+). **Rel. 17:** 51 km south of Perenjori. *Petrophile shuttleworthiana* (+). **Rel. 18:** 63 km south of Perenjori. *Hakea bucculenta* (+), *Phebalium microphyllum* (+). **Rel. 19:** 88 km south of Perenjori. *Brachysema tomentosum* (+), *Chorizema acicularis* (+), *Loxocarya flexuosa* (+), *Mallophora rugosifolia* (+), *Mesomelaena tetragona* (+), *Patersonia occidentalis* (+), *Verticordia polytricha* (+), *Anarthria* sp. (+), *Dampiera* sp. (+), *Verticordia* sp. (+). **Rel. 20:** 123 km south of Perenjori. *Drosera pallida* (+), *Hypocalymma angustifolium* (+), *Leucopogon striatus* (+), *Pimelea imbricata* (+), *Trymalium* cfr. *ledifolium* (+). **Rel. 21:** 1 km south of Pithara (water catchment). *Borya sphaerocephala* (+), *Briza maxima* (1), *Dampiera linearis* (+), *Drosera macrantha* (+), *Eremophila maculata* (+), *Gnephosis gonotricha* (+), *Hydrocotyle blepharocarpa* (+), *Hypoxis occidentalis* (+), *Loxocarya cinerea* (+), *Phyllangium paradoxum* (+), *Scaevola spinescens* (+). **Rel. 22:** Near roadside and foothill of Jilbadge Rock; with single high trees plus mallee surface probably a few years after a fire; 11.09.94. *Disphyma crassifolium* (+), *Haloragis nodiflora* (+), *Senecio lautus* (+), *Lomandra* sp. (+), *Melaleuca* sp. (2). **Rel. 23:** Near roadside and foothill of Jilbadge Rock, mallee with few scattered higher trees; light brown sand, gravelly; 11.09.94. *Amyema miquelii* (on *Eucalyptus*) (+), *Grevillea* cfr. *asparagoides* (+), *Daviesia* sp. (+), *Sida* sp. (+). **Rel. 24:** East of Yilbadge Rock, near roadside, mallee with scattered rare taller trees; hard loamy brown sand; 11.09.94. *Callitris roei* (1), *Lomandra* sp. (+), *Melaleuca* sp. (2). **Rel. 25:** 39 km south of petrol station near Southern Cross, close to cross section 16 km SW of Moorine Rock on Southern Cross South Road towards Aramasco Road; 11.09.94. *Allocasuarina obesa* (1), *Danthonia* cfr. *caespitosa* (+), *Hakea erecta* (+), *Lepidosperma drummondii* (+), *Petrophile ericoides* (+), *Stylidium repens* (+), *Verticordia roei* (+), *Daviesia* sp. (+), *Hibbertia* sp. (+), *Hibbertia* sp. (+). **Rel. 26:** 87 km from Moorine Rock southwards. Mallee on gravelly sand; 12.09.94. *Baeckea behrii* (2), *Borya nitida* (+), *Chamaelaucium brevifolium* (+), *Dryandra cyrsoides* (+), *Dryandra* sp. (+) *Hibbertia* sp. (+), *Persoonia* sp. (+), *Persoonia* sp. (+). **Rel. 27:** 140 km South of Moorine Rock in direction Hyden; gravels; 12.09.94. *Dryandra* aff. *nivea* (+), *Hibbertia* sp. (1), *Hibbertia* sp. (+), *Phebalium* sp. (+).\l **Rel. 28:** 70 km before Lake King from direction Hyden; mallee above kwongan, gravel over loamy sand; 12.09.94. *Allocasuarina acutivalvis* (2), *Callitris drummondii* (+), *Grevillea shuttleworthiana* (+), *Cryptandra* sp. (+), *Hibbertia* sp. (+), *Leucopogon* sp. (+), *Pimelea* sp. (+). **Rel. 29:** Frank Hann National Park, mallee on loamy sand; 13.09.94. *Anarthria prolifera* (+), *Daviesia spinosissima* (+), *Patersonia umbrosa* (+), *Persoonia tortifolia* (+), *Beaufortia* sp. (+), *Hibbertia* sp. (+), *Cyperaceae* (+). **Rel. 30:** Frank Hann National Park, mallee 3 m high, white sand; 13.09.94. *Allocasuarina humilis* (+),

*Cassytha pomiformis* (+), *Dryandra armata* (+), *Synaphea petiolaris* (+), *Conostylis* sp. (+), *Dampiera* sp. (+), *Juncus* sp. (+), *Loxocarya* sp. (+). **Rel. 31:** Frank Hann National Park, on sidetrack, reddish-grey loam with iron pebbles on surface; 13.09.94. *Isopogon teretifolius* (+), *Boronia* sp. (+). **Rel. 32:** Towards the eastern end of Frank Hann National Park, near main road, kwongan with low mallee on yellow sand; 13.09.94. *Calothamnus asper* (+), *Darwinia luekmannii* (+), *Grevillea excelsior* (+), *Hakea* cfr. *recurva* (+), *Leucopogon* sp. (+). **Rel. 33:** Cascade Rd. – Oldfield Rd. *Cassytha melantha* (+). **Rel. 34:** Cascade Rd. – Oldfield Rd. **Rel. 35:** Cascade Rd. – Oldfield Rd. *Caustis dioica* (+), *Chamaexeros fimbriata* (+), *Dielsia crispata* (+), *Hakea cinerea* (+), *Hakea corymbosa* (1), *Hakea ruscifolia* (+), *Isopogon trilobus* (+), *Phymatocarpus maxwellii* (+), *Regelia inops* (+), *Sollya heterophylla* (+). **Rel. 36:** Cascade Rd. – Oldfield Rd. *Beaufortia schaueri* (+), *Calothamnus quadrifidus* (+), *Hakea laurina* (1), *Lambertia inermis* (+). **Rel. 37:** Cascade Rd. – Oldfield Rd. *Astartea heteranthera* (+), *Calectasia* sp. nov. (+), *Daviesia euphorbioides* (+), *Hakea laurina* (+), *Halgania lavandulacea* (+), *Daviesia* sp. (+), *Leucopogon* sp. (+), *Cyperaceae* (+).

Species which could not be determinated exactly are listed under "sp."; sporadic species in the phytosociologic sense are species which occur only as a single individual in the plots and whose occurrence seems to have no importance for the species combination of the community.

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# A PHYTOSOCIOLOGICAL STUDY OF THE HYGROPHILOUS VEGETATION OF SIERRA NEVADA (SOUTHERN SPAIN)

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**Keywords:** Chorology, Dynamics, Ecology, Edapho-hygrophilous communities, Riparian vegetation.

**Abstract:** A study on the vegetation related to streams and rivers of the Nevadense sector of Sierra Nevada (Southern Spain) has been carried out by determining its main structural, floristic, ecological, chorologic and dynamic characteristics. A total of nine new syntaxa have been highlighted: four associations (*Caricetum camposii-cuprinae, Ranunculo granatensis-Cochlearietum megalospermae, Cirsio micranthi-Scirpetum holoschoeni, Carici camposii-Salicetum atrocinereae*), two subassociations (*Myrrhoidi-Alliarietum petiolatae nepetosum granatensis, Carici camposii-Salicetum atrocinereae salicetosum capreae*), two variants (*Rubo-Rosetum corymbiferae* variant with *Adenocarpus decorticans, Rubo-Coriarietum myrtifoliae* variant with *Adenocarpus decorticans*) and one community (*Cratoneuron commutatum* and *Anagallis tenella* community).

## Introduction

The vegetation of Sierra Nevada, and particularly that of the siliceous nucleus (the so-called Nevadense sector) has been the subject of numerous studies carried out during the second half of the last (e.g. Quézel 1953; Rivas-Martínez 1961; Rivas Goday & Mayor 1966; Prieto 1971; Valle 1985; Rivas-Martínez *et al.* 1986; Losa-Quintana *et al.* 1986; Martínez-Parras *et al.* 1987a, 1987b; Mota & Valle 1987; Molero-Mesa 1988; Pérez-Raya *et al.* 1990; Molero-Mesa *et al.* 1992; Aallali *et al.* 1998 and Molero-Mesa 1999). However, none of these works deals with the hygrophilous vegetation, with the exception of Casares *et al.* (1986), Martínez-Parras *et al.* (1987c) and Losa-Quintana *et al.* (1987), who studied the cryoro-Mediterranean and oro-Mediterranean peat-bog communities (the typical Nevadense "borreguil", a high-mountain hygrophilous pasture) as well as the riparian communities of the Genil River basin.

The studies of the riparian vegetation in other basins with Nevadense tributaries, such as those of the rivers Andarax (Salinas & Blanca 1996) and Guadiana Menor (Salazar 1996; Salazar *et al.* 1999), provided new data on traditionally little-studied phytocoenoses, but generally only single floristic, ecological and landscape aspects were considered.

In this study we will discuss data concerning some interesting plant communities related to streams and rivers of the Nevadense sector of Sierra Nevada, developed mainly in areas of the meso-Mediterranean and supra-Mediterranean thermotypes but in some cases reaching the oro-Mediterranean, which had been completely ignored, or has only been briefly discussed by previous authors.

## Study area

The Sierra Nevada massif (Fig. 1) is situated in the south-eastern Iberian Peninsula and belongs to two political provinces, Granada and Almeria. It has an oval shape with an E-W main axis. Altitudes range from less than 700 m at the Alpujarras level up to 3.481 m (Mulhacen peak, the highest mountain of the Iberian Peninsula).

The massif, which belongs to the inner areas of the Baetic Mountains, was formed during the Alpine folding and is lithologically heterogeneous. The peripheral areas of the range have a limestone edge, whereas the central siliceous nucleus is dominated by mica-schists, quartzites and phyllites, clearly defining what is known as the Nevadense sector.

Watercourses flowing through Sierra Nevada correspond to two hydrographic basins: the Guadalquivir, which is the main river of the

southern part of the Iberian Peninsula, with the Genil and Guadiana Menor as main tributaries, and the South basin, flowing directly into the Mediterranean Sea, with the Guadalfeo and Andarax as most important rivers.

According to Rivas-Martínez *et al.* (1997), Sierra Nevada biogeographically belongs to three sectors of the Baetic province. The limestone edge and the southern slopes belong to the Malacitano-Almijarense and Alpujarreño-Gadorense sectors respectively, whereas our study area, consisting of the central siliceous part, belongs to the Nevadense sector. The latter is divided into two districts: Nevadense – mostly towards the West and to which Sierra Nevada pertains – and Filábrico – mostly towards the East, to which the Sierra de Filabres pertains. Although this study deals with the vegetation of rivers and streams of both districts, the riparian vegetation is better developed in the Nevadense district due to higher rainfall, whereas in the Filábrico it is scarcer and poorer as the water level is slightly lower.

Bioclimatically, the Sierra Nevada is dominated by the Mediterranean macrobioclimate of the pluviseasonal type, with continental or oceanic influences (Rivas-Martínez 1996), being characterised by a prolonged period of summer drought and precipitations (rain or snow) restricted to winter and spring. The following thermotypes are present: cryoro-Mediterranean, oro-Mediterranean, supra-Mediterranean, meso-Mediterranean and, occasionally, thermo-Mediterranean, as well as the hyperhumid, humid, subhumid and dry ombrotypes.

From the floristic point of view, the Sierra Nevada massif is considered to be the most important area for plant diversity in the western Mediterranean region, gathering over 7% of the Mediterranean flora in just 0.01% of its surface (Blanca *et al.* 1998). The Sierra Nevada's rate of endemic taxa is outstanding: the massif constitutes one of the most important "hot spots" in Europe, with endemicity rates reaching 30-40% in culminant areas or even surpassing 80% in certain ecosystems (Blanca *et al.* 1998). Nearly 6% of the flora (116 taxa) is endangered, in the majority of cases being included in the IUCN's higher risk categories. Over 30 species are found in the edapho-hygrophilous vegetation of the Nevadense sector described in this paper. These taxa are partly protected by regional, national and international laws on account of their relevance.

## Data and methods

The vegetation was studied following the phytosociological method of the Zurich-Montpellier school (Braun-Blanquet 1979), as modified by Géhu & Rivas-Martínez (1982). Relevés of the edapho-hygrophilous communities of banks and watercourses were carried out between 1993-1999 in different localities of the study area.

In the tables, species have been generally clustered into two groups: characteristics of association plus higher syntaxa, and accompanying species. Exceptionally, other groups such as characteristics of subassociation, characteristics of variant, etc. have been included.

The relevés have been classified according to phytosociological criteria, revealing the associations present in the area. The relevés, which could not be related to any known syntaxon, have been described and classified as new associations and subassociations. Where information was scarce, they have been referred to as "communities".

Each association has been described by taking the following elements into consideration: structure, ecology, physiognomy, ecological characteristics, chorology (specifying the biogeographical distribution up to the district level by using the classification of Rivas-Martínez *et al.* 1997). Finally, the study deals with the phytocoenosis dynamics, dynamic significance and relationships with other communities.

Two units, subassociation and variant, have been considered to belong to a lower hierarchical rank than that of association. As for subassociation, the concept of geographical race (Alcaraz 1996) has been used when the floristic combination does not hold sufficient characteristics to be considered as an association. On the other hand, when a community

is diversified within the same territory for bioclimatic, edaphic, ecotonal situations, etc., it has been considered as a variant.

The nomenclature of syntaxa follows the International Code of Phytosociological Nomenclature (Barkman *et al.* 1988). The phytosociological typology used up to the suballiance level follows Rivas-Martínez *et al.* (1999).

Nomenclature of taxa follows, when possible, *Flora ibérica* (Castroviejo *et al.* 1986, 1990, 1993a, 1993b, 1997a, 1997b; Muñoz-Garmendia & Navarro 1998; Talavera *et al.* 1999), otherwise *Flora Europaea* (Tutin *et al.* 1964-1980). Monographs have been used for *Agrostis* (Romero *et al.* 1988), *Carex* (Luceño 1994), *Cirsium* (Talavera & Valdés 1976), *Juncus* (Fernández-Carvajal 1981, 1982a, 1982b, 1983) and *Salix* (Díaz González & Llamas 1987).

The taxa for which different criteria have been followed are indicated herein:

*Digitalis purpurea* L. var. *nevadensis* (Kunze) Amo [Flora Fanerogámica de la Península Ibérica III:350 (1872)]. *Festuca trichophylla* (Ducros ex Gaudin) K. Richter subsp. *scabrescens* (Hackel ex Trabut) Catalàn & Stace [Anales Jard. Bot. Madrid 50(2): 219 (1992)]. *Lotus pedunculatus* Cav. subsp. *granadensis* (Zertovà) Molero Mesa & Pérez Raya [La Flora de Sierra Nevada: 152 (1987)]. *Luzula campestris* (L.) DC. subsp. *nevadensis* P. Montserrat [Anales Inst. Bot. Cavanilles 21(2)]. *Scrophularia auriculata* Loefl. *ex* L. [Sp. Pl. 620 (1753)].

## Results and discussion

### A) Spring, amphibious and peat-bog vegetation

*Cratoneuron commutatum* and *Anagallis tenella* community (Tab. 1)

Bryo-cormophytic community in which the moss stratum (*Cratoneuron commutatum* and *Philonotis seriata*) forms a continuous carpet 5-10 cm thick, on which abundant plants of *Anagallis tenella* develop. The presence of *Pinguicula grandiflora* in the community should also be highlighted. It occurs in permanently waterlogged areas on distric gleysols or along watercourses, carpeting stones splashed by water. Its oligotrophic nature is revealed by the presence of *Calliergonella cuspidata* and *Parnassia palustris.*

This community appears at least in the Nevadense district (its presence in the Filábrico district has yet to be detected) where it covers small areas in the upper meso-, supra- and oro-Mediterranean thermotypes. A similar community developed on carbonated substrata and waters (*Cratoneuron filicinum* and *Anagallis tenella* community) was described by Ríos (1996:521) from Sierra de Segura (Sub-Baetic sector).

In waterlogged soils it comes into contact with the helophytic *Caricetum camposii-cuprinae* and *Festuca ampla* grass communities (*Euphrasio-Festucetum amplae* Martínez-Parras, Peinado *et* Alcaraz 1987). In less humid areas it comes into contact with *Juncion acutiflori* rush-beds or with the more sciophilous *Aquilegio-Ranunculetum granatensis* Martínez-Parras, Peinado *et* Alcaraz 1987 grass formations.

*Caricetum camposii-cuprinae* Salazar, Lorite, Cano *et* Valle *ass. nova* (Tab. 2, *holotypus* rel. n. 9)

An association dominated by large hemicryptophytes of the genus *Carex* occupying slopes which are permanently humid due to water coming from adjacent streams. It develops on base-poor, peat-bog like substrata that are often removed by animals, which form numerous, permanently flooded micro-depressions. With optimum in the supra-Mediterranean and oro-Mediterranean thermotypes, it may occasionally be found above the meso-Mediterranean belt.

The most characteristic and predominant species is the Nevadense endemism *Carex camposii*, accompanied by *Carex cuprina, Juncus articulatus, Eleocharis palustris, Cyperus longus, Alchemilla straminea, Primula elatior* subsp. *lofthousei*, etc. The aggressive livestock action (mainly by cattle) makes it difficult to identify with clarity the abundant different species of *Cyperaceae*, in many cases even preventing the community from reaching normal development. Because of the predation of its inflorescences, *Carex camposii* undergoes strong vegetative propagation, thus increasing its cover. Furthermore, livestock activity favours the enrichment in *Agropyro-Rumicion* crispi elements, above all in the less flooded areas.

The new association was previously reported by Losa-Quintana *et al.* (1986:228) as "*Carex camposii* community", but they did not provide either relevés or information regarding its ecology and floristic composition. It was also cited by Casares *et al.* (1986:450) as a new association called *Laserpitio longiradii-Caricetum camposii* Molero-Mesa *et* Pérez-Raya (unpublished), but these authors report neither relevés nor a description of the community. Furthermore, *Laserpitium longiradium* was considered as a characteristic species, but this Nevadense endemic is not related to helophytic formations.

Tab. 1 - *Cratoneuron commutatum* and *Anagallis tenella* community

| Rel. number | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Altitude (m) | 1300 | 2050 | 1690 | 1750 | 1710 | 1740 | 2000 |
| Area ($m^2$) | 2 | 2 | 1 | 2 | 2 | 2 | 4 |
| Average height (cm) | 15 | 10 | 5 | 10 | 5 | 15 | 5 |
| Cover (%) | 100 | 100 | 100 | 100 | 95 | 100 | 75 |
| Number of taxa | 15 | 15 | 14 | 17 | 18 | 19 | 17 |
| **Characteristics of association and higher units:** | | | | | | | |
| *Cratoneuron commutatum* | 1 | 3 | 4 | 3 | 3 | 4 | 1 |
| *Anagallis tenella* | 3 | . | 1 | 3 | 1 | 1 | . |
| *Philonotis seriata* | 3 | 1 | 1 | 1 | . | 2 | 1 |
| *Parnassia palustris* | . | 2 | 1 | 2 | + | + | + |
| *Pinguicula grandiflora* | . | 2 | 2 | . | 1 | + | 1 |
| *Calliergonella cuspidata* | . | . | . | 1 | 2 | 1 | . |
| *Pholia cruda* | . | . | . | . | . | . | 1 |
| *Jungermannia exsertifolia cordifolia* | . | . | . | . | . | . | 1 |
| *Reboulia hemisphaerica* | . | . | . | . | . | . | 1 |
| **Accompanying species:** | | | | | | | |
| *Trifolium repens* | 1 | 2 | 1 | + | 1 | 2 | + |
| *Sagina procumbens* | . | 1 | 2 | 1 | 1 | 2 | 1 |
| *Luzula campestris nevadensis* | . | 1 | + | + | 1 | + | + |
| *Viola palustris palustris* | . | 3 | . | 2 | + | + | 1 |
| *Euphrasia wilkommii* | . | + | 1 | + | + | . | . |
| *Ranunculus repens* | . | + | + | + | . | + | . |
| *Prunella vulgaris* | 1 | . | . | 1 | + | . | . |
| *Holcus lanatus* | + | . | . | . | + | + | . |
| *Lotus pedunculatus granadensis* | . | 2 | . | . | + | 1 | . |
| *Carex camposii* | . | . | . | + | + | + | . |
| *Juncus articulatus* | . | . | . | + | + | + | . |
| *Lotus uliginosus* | 1 | . | . | 1 | . | . | . |
| *Hypericum tetrapterum* | + | . | + | . | . | . | . |
| *Agrostis nevadensis* | . | 2 | . | . | . | . | + |
| *Festuca tricophylla scabrescens* | . | 1 | . | . | . | . | + |
| *Cerastium fontanum* | . | . | + | + | . | . | . |
| *Primula elatior lofthousei* | . | . | | + | + | . | . |
| *Festuca ampla* | . | . | . | . | + | + | . |
| *Epilobium obscurum* | . | . | . | . | + | + | . |
| *Lotus corniculatus* | 2 | . | . | . | . | . | . |
| *Carex lepidocarpa* | 1 | . | . | . | . | . | . |
| *Blackstonia perfoliata* | 1 | . | . | . | . | . | . |
| *Leontodon microcephalus* | . | 1 | . | . | . | . | . |
| *Carex capillaris* | . | . | . | . | . | . | 1 |

**Sporadic species:** Rel.1: *Epilobium parviflorum* +; *Dactylorrhiza elata sesquipedalis* +; *Cirsium pyrenaicum micranthum* +; *Sonchus maritimus aquatilis* +. Rel.2: *Sedum melanantherum* +. Rel.3: *Juncus inflexus* +; *Lythrum portula* +. Rel. 6: *Leontodon carpetanus nevadensis* +; *Mentha spicata* +. Rel. 7: *Galium sp.* +; *Gentiana verna sierrae* +; *Epilobium alsinifolium*, +.

**Localities:** 1: Granada: Río Alhama de Lugros, Dehesa del Camarate, VG7716. 2: Almería: Abrucena, Barranco de la Campana, WG1005. 3: Almería: Fiñana, barranco del Rosal, WF0706. 4: Almería: Bayárcal, Arroyo Anchuelo, WG0002. 5: Almería: Fiñana, barranco del Rosal, WF0706. 6: Almería: Laujar de Andarax, Barranco del Horcajo, WG0802. 7: Almería: Abrucena, barranco de Peña Horadada, WG1205.

Tab. 2 - *Caricetum camposii-cuprinae* Salazar, Lorite, Cano *et* Valle *ass. nova*

| Rel. number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Altitude (m) | 1700 | 1690 | 1720 | 1550 | 2270 | 1540 | 1800 | 1800 | 1900 | 1900 | 2120 |
| Area ($m^2$) | 10 | 10 | 10 | 15 | 15 | 10 | 2 | 2 | 50 | 4 | 6 |
| Average height (cm) | 50 | 100 | 50 | 50 | 50 | 50 | 25 | 25 | 25 | 40 | 60 |
| Cover (%) | 100 | 100 | 100 | 100 | 100 | 100 | 85 | 90 | 90 | 90 | 100 |
| Number of taxa | 16 | 16 | 22 | 15 | 9 | 15 | 10 | 18 | 28 | 10 | 24 |
| **Characteristics of association and higher units:** | | | | | | | | | | | |
| *Carex cuprina* | 4 | 2 | 3 | 4 | 4 | 3 | 1 | 2 | 2 | 1 | 3 |
| *Carex camposii* | 3 | 3 | 2 | 1 | 1 | 2 | 4 | 5 | 5 | 4 | 4 |
| *Veronica beccabunga* | . | 2 | + | . | . | . | + | + | 1 | . | . |
| *Juncus articulatus* | . | . | . | . | . | . | 1 | 1 | 1 | 1 | 1 |
| **Accompanying species:** | | | | | | | | | | | |
| *Holcus lanatus* | 1 | 2 | 1 | 2 | . | 1 | + | 1 | 1 | 2 | 2 |
| *Hypericum tetrapterum* | 1 | + | 1 | . | . | 2 | . | 1 | + | . | 1 |
| *Trifolium repens nevadense* | 1 | . | 1 | 1 | . | . | - | 2 | 1 | 2 | 2 |
| *Juncus inflexus* | . | 1 | 1 | + | . | . | 2 | 2 | + | . | + |
| *Mentha longifolia* | . | 2 | . | 1 | . | 2 | + | 1 | 1 | . | 1 |
| *Cirsium pyrenaicum micranthum* | 1 | . | 1 | + | . | 1 | 1 | . | 2 | . | . |
| *Lotus uliginosus* | 2 | . | 1 | . | . | 2 | . | 2 | . | . | 2 |
| *Dactylorrhiza elata* | + | . | + | + | . | 1 | . | . | . | . | + |
| *Aquilegia vulgaris nevadensis* | + | . | . | . | . | + | . | . | 1 | + | 1 |
| *Primula elatior lofthousei* | 2 | . | 1 | . | . | 1 | . | . | 1 | . | . |
| *Anthoxanthum odoratum* | 2 | . | . | . | . | + | . | 1 | . | . | + |
| *Agrostis castellana castellana* | + | + | . | + | . | . | . | . | + | . | . |
| *Carum verticillatum* | + | . | . | . | + | . | . | . | + | . | 2 |
| *Alchemilla straminea* | + | . | 2 | . | . | . | . | . | + | . | 1 |
| *Ranunculus granatensis* | . | 1 | . | + | . | . | . | . | 1 | . | 1 |
| *Peucedanum hispanicum* | . | . | + | . | . | 1 | . | . | + | . | 2 |
| *Ranunculus repens* | . | . | 1 | . | . | . | . | + | 1 | 1 | . |
| *Geum urbanum* | . | . | . | . | . | . | 1 | 2 | . | 1 | + |
| *Epilobium obscurum* | . | 2 | + | 1 | . | . | . | . | . | . | . |
| *Anthriscus sylvestris* | . | + | 1 | . | . | + | . | . | . | . | . |
| *Myosotis decumbens teresiana* | . | + | + | . | . | . | . | . | . | . | + |
| *Prunella vulgaris* | . | . | . | . | . | . | 1 | 2 | + | . | . |
| *Trifolium pratense* | . | . | . | . | . | . | . | 1 | 1 | . | 1 |
| *Cerastium fontanum* | . | . | . | . | . | . | . | + | + | . | + |
| *Carex nigra* | + | . | . | + | . | . | . | . | . | . | . |
| *Festuca ampla* | . | 2 | 2 | . | . | . | . | . | . | . | . |
| *Urtica dioica* | . | + | . | . | . | + | . | . | . | . | . |
| *Mentha suaveolens* | . | . | + | 1 | . | . | . | . | . | . | . |
| *Juncus effusus subglomeratus* | . | . | . | . | . | . | . | . | . | 1 | + |

**Sporadic species:** Rel.1: *Brachypodium sylvaticum* +. Rel.2: *Rumex conglomeratus* +; *Lathyrus pratensis* +. Rel.3: *Aconitum vulparia neapolitanum* +; *Epilobium tetragonum tetragonum* +; *Cirsium x nevadense* +. Rel.4: *Scirpus holoschoenus* +; *Mentha spicata* +; Rel.5: *Nardus stricta* 1; *Potentilla nevadensis* 1; *Lotus glareosus* 1; *Juncus conglomeratus* 1; *Carex lepidocarpa* +; *Galium verum verum* +. Rel.6: *Athyrium filix-foemina* 1. Rel.8: *Epilobium atlanticum* +; *Montia fontana fontana* +. Rel.9: *Scirpus cernuus* 2; *Cirsium* pyrenaicum *longespinosum* 1; *Cirsium pyrenaicum* pyrenaicum 1; *Cochlearia megalosperma* +; *Ligusticum lucidum* +; *Parnassia palustris* +; *Juncus conglomeratus* +. Rel.10: *Stellaria alsine* 1. Rel. 11: *Dryopteris filix-mas* +; *Poa trivialis* +; *Briza media* 1.

**Localities:** 1: Almería: Paterna del Río, Barranco de los Cerezos WG0303. 2 and 3: Almería: Fiñana, Barranco del Rosal, WF0706. 4: Almería: Bayárcal, Arroyo del Palancón, VG9801. 5: Almería: Laujar de Andarax, cabecera del Barranco del Horcajo. WG0704. 6: Almería: Beires, cabecera del rio Ohanes, WG1801. 7 and 8: Granada: Dehesa del Camarate, VG7614. 9: Granada: Dehesa del Camarate, VG7613. 10: Granada: Río Barrio, VG8708. 11: Granada: Río Dílar, VG6102.

The *Caricetum camposii-cuprinae* is a typical association of the Nevadense sector, being widely distributed due to the large amount of gullies where peat-bog like soils are formed and *Carex camposii* can proliferate. Its presence has been observed in Sierra Nevada (Nevadense district) and in Sierras of Baza and Filabres (Filábrico district), in the latter with less hygrophilous endemic species.

In more sloped areas with non-waterlogged soils, this helophytic formation comes into contact with the megaforbic association *Aconito-Senecietum elodis* Quézel 1953. Towards areas closer to rivers and streams, on compacted, flat, humid but non-waterlogged soils, it usually comes into contact with rush-beds of *Cirsio micranthi-Juncetum effusi* Salazar, Cano *et* Valle in Salazar *et al.* 1999 and *Aquilegio nevadensis-Ranunculetum granatensis* grass communities. Under stronger nitrification by livestock it comes into contact with rush-beds of *Cirsio-Juncetum inflexi* Vigo 1968. Where the association is directly in contact with streams and creeks, these will be carpeted with watercress silicicolous communites (*Glycerio declinatae-Apietum nodiflori* J.A. Molina 1996).

**B) Wood-fringe and megaforbic vegetation**

*Ranunculo granatensis-Cochlearietum megalospermae* Salazar, Lorite, Valle *et* Cano *ass. nova* (Tab. 3, *holotypus* rel. n. 6)

Thick megaforbic grass community developed on siliceous rocks, mainly mica-schists, which emerges within strongly flowing streams and clean, oligotrophic waters. It can occasionally appear on more or less developed humid soils, near streams with a stable water level which never undergo a deep decrease in their water level. With a supra-Mediterranean optimum, this association, in certain cases, can descend to the meso-Mediterranean belt.

It occupies shaded areas, being absent in open ones. Occasionally, *Cochlearia megalosperma* appears in sunnier areas, being integrated with the megaforbic grass communities of *Senecionion fluviatilis*. Faithful species to this formation are *Myosotis decumbens* subsp. *teresiana, Hypericum tetrapterum, Senecio jacobaea, Peucedanum hispanicum, Holcus lanatus* and *Lotus uliginosus*, besides the two principal species.

This association has been observed in Sierra Nevada and could theoretically be found -although poorer in species- in Sierra de Filabres (Filábrico district), or even in the Serrano-Bacense district (Baza Sierra). It may also be present in North Africa, because *Cochlearia megalosperma* is an Iberian-North-African endemism.

This association can be interpreted as a pioneer phase to the setting up of silicicolous *Salix atrocinerea* (occasionally, *Salix caprea*) willows since it occupies gravel along streambeds. When it occurs on deeper soils, it may come into contact with other Nevadense communities such as rushes (*Cirsio micranthi-Juncetum effusi*), megaforbic grass (*Aquilegio-Ranunculetum granatensis*) and sedge communities of flooded substrata (*Caricetum camposii-cuprinae*).

*Myrrhoidi nodosae-Alliarietum petiolatae* Rivas-Martínez *et* Mayor *ex* V. Fuente 1986 *nepetosum granatensis subass. nova* (Tab. 4, *holotypus* rel. n. 5)
Synonym: *Alliario petiolatae-Laserpitietum longiradii* Losa-Quintana 1986

Scio-nitrophilous herbaceous community of clearings within deciduous forests. It develops on deep soils, with a certain nitrification and under cover of dead leaves. Of limited coverage and average size, this community has its optimum in the subhumid supra-Mediterranean belt. Phenologically, it has a clear maximum in spring, when the most important species (*Alliaria petiolata* and *Myrrhoides nodosa*) bloom; in summer they wither and sprout new shoots. The accompanying species are *Urtica dioica, Anthriscus sylvestris, Chaerophyllum hirsutum, Nepeta granatensis*, *Heracleum granatense*, etc.

This association was first described in the Guadalajara province by Fuente (1986) but it seems to have a wider distribution with its southernmost limit corresponding to our survey area. Losa-Quintana *et al.* (1986:181) consider the *Alliario-Laserpitietum longiradii* Losa-Quintana 1986 association as endemic to Sierra Nevada, but they had probably identified *Laserpitium longiradium* for *L. gallicum* or *L. latifolium*, since the only localities of *L. longiradium* are in the Monachil River gully (Malacitano-Almijarense sector), on scio-nitrophilous stratum limestone of evergreen oak groves (Blanca, *pers. comm.*). Therefore, it seems more appropriate to consider this community as a subassociation, called *nepetosum granatensis*, supported by Baetic elements such as *Nepeta granatensis* and *Heracleum granatense*, spreading at least over the Nevadense and Sub-Baetic sectors, in relation to which similar communities have been already cited (Ríos 1996).

This community, which has a rather short growing season, appears in the undergrowth of alder forests, athrocinereous willows and goat-willows of Sierra Nevada; when it occurs along streamsides, it comes into contact with *Aquilegio-Ranunculetum granatensis* communities or with different rushes or helophytic communities.

Tab. 3 - *Ranunculo granatensis-Cochlearietum megalospermae* Salazar, Lorite, Cano *et* Valle *ass. nova*

| Rel. number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Altitude (m) | 1600 | 1600 | 1980 | 1700 | 1520 | 1550 | 1700 | 1440 | 1460 |
| Area ($m^2$) | 2 | 1 | 4 | 10 | 2 | 1 | 2 | 2 | 1 |
| Average height (cm) | 150 | 70 | 120 | 100 | 100 | 100 | 100 | 25 | 100 |
| Cover (%) | 90 | 100 | 95 | 90 | 100 | 100 | 100 | 80 | 90 |
| Number of taxa | 11 | 11 | 10 | 8 | 9 | 13 | 15 | 10 | 11 |
| **Characteristics of association and higher units:** | | | | | | | | | |
| *Cochlearia megalosperma* | 4 | 2 | 4 | 4 | 4 | 3 | 2 | 2 | 2 |
| *Hypericum tetrapterum* | 1 | + | 2 | 1 | 2 | 2 | + | + | 1 |
| *Peucedanum hispanicum* | . | 2 | . | . | 3 | + | . | 1 | . |
| *Senecio jacobaea* | . | + | 1 | . | . | . | 1 | . | . |
| *Ranunculus granatensis* | . | . | . | 2 | + | + | . | . | 2 |
| *Scrophularia auriculata* | . | . | . | . | . | . | 1 | + | . |
| **Accompanying species:** | | | | | | | | | |
| *Holcus lanatus* | 2 | . | 2 | . | 3 | 4 | 4 | 4 | 3 |
| *Myosotis decumbens teresiana* | . | . | 1 | 2 | . | 1 | 1 | + | + |
| *Lotus uliginosus* | + | . | 1 | . | . | 1 | 1 | . | + |
| *Mentha longifolia* | . | . | . | 1 | 1 | + | 2 | . | + |
| *Carex camposii* | . | . | 1 | . | 1 | 2 | + | . | . |
| *Geranium purpureum* | + | 2 | . | . | . | . | . | + | . |
| *Brachypodium sylvaticum* | + | + | . | . | + | . | . | . | . |
| *Poa nemoralis* | 2 | . | . | 1 | . | . | . | . | . |
| *Urtica dioica* | + | + | . | . | . | . | . | . | . |
| *Rubus ulmifolius* | + | + | . | . | . | . | . | . | . |
| *Athyrium filix-foemina* | . | 1 | . | . | . | . | . | + | . |
| *Dactylorhiza elata sesquipedalis* | . | . | + | . | . | . | + | . | . |
| *Cardamine flexuosa* | . | . | . | 1 | . | . | 1 | . | . |
| *Anthoxanthum odoratum* | . | . | . | . | . | 1 | . | + | . |
| *Clinopodium vulgare arundanum* | . | . | . | . | . | + | + | . | . |
| *Lonicera peryclimenum hispanica* | + | . | . | . | . | . | . | . | . |
| *Anthriscus sylvestris* | + | . | . | . | . | . | . | . | . |
| *Mentha suaveolens* | . | 3 | . | . | . | . | . | . | . |
| *Epilobium obscurum* | . | 2 | . | . | . | . | . | . | . |
| *Agrostis canina canina* | . | . | 1 | . | . | . | . | . | . |
| *Juncus inflexus* | . | . | + | . | . | . | . | . | . |
| *Apium nodiflorum* | . | . | . | 1 | . | . | . | . | . |
| *Juncus effusus subglomeratus* | . | . | . | . | + | . | . | . | . |
| *Ranunculus repens* | . | . | . | . | . | 2 | . | . | . |
| *Cerastium fontanum* | . | . | . | . | . | + | . | . | . |
| *Geranium columbinum* | . | . | . | . | . | . | 1 | . | . |
| *Hypochaeris radicata* | . | . | . | . | . | . | + | . | . |
| *Lapsana communis* | . | . | . | . | . | . | + | . | . |
| *Scrophularia scorodonia* | . | . | . | . | . | . | . | + | . |
| *Ligusticum lucidum* | . | . | . | . | . | . | . | . | 1 |
| *Cirsium pyrenaicum micranthum* | . | . | . | . | . | . | . | . | + |
| *Euphorbia characias* | . | . | . | . | . | . | . | . | + |
| *Heracleum sphondylium granatense* | . | . | . | . | . | . | . | . | + |

**Localities:** 1: Almeria: Fiñana, Arroyo de Lubeire, WG0907. 2: Almeria; Bayárcal, Arroyo Anchuelo, WG0001. 3: Almeria: Paterna del Rio, Barranco de los Murillos, WG0304. 4: Almeria: Paterna del Rio, Barranco del Saltadero, WG0401. 5: Granada Arroyo del Alhori, VG8211. 6: Granada: Arroyo del Alhori, VG8111. 7: Granada: Barranco de las Rozas, VG7614. 8: Granada: Arroyo del Alhori, VG8312. 9: Granada: Rio Dilar, VG5601.

Tab. 4 - *Myrrhoidi nodosae-Alliarietum petiolatae* Rivas-Martínez *et* Mayor *ex* V. Fuente *nepetosum granatensis subass. nova.*

| Rel. number | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Altitude (m) | 1830 | 1830 | 1500 | 1600 | 1400 |
| Area ($m^2$) | 25 | 25 | 4 | 2 | 4 |
| Average height (cm) | 40 | 40 | 25 | 25 | 30 |
| Cover (%) | 95 | 95 | 75 | 85 | 80 |
| Number of taxa | 12 | 10 | 13 | 11 | 15 |
| **Characteristics of association and higher units:** | | | | | |
| *Alliaria petiolata* | 3 | 3 | 2 | 3 | 2 |
| *Urtica dioica* | 3 | 3 | + | 2 | 2 |
| *Myrrhoides nodosa* | . | . | 1 | 1 | + |
| *Anthriscus sylvestris* | . | . | 2 | 1 | 3 |
| *Galium aparine* | . | . | . | 1 | 2 |
| **Differentials of subass. *nepetosum granatensis:*** | | | | | |
| *Heracleum sphondylium granatense* | . | . | 1 | . | 2 |
| *Nepeta granatensis* | . | . | + | . | 1 |
| **Accompanying species:** | | | | | |
| *Stellaria media* | 2 | 2 | . | 2 | 1 |
| *Saxifraga granulata* | 1 | . | 1 | . | 2 |
| *Galium spurium* | 1 | 1 | . | . | . |
| *Cerastium gibraltaricum* | + | 1 | . | . | . |
| *Dactylis glomerata hispanica* | + | 1 | . | . | . |
| *Centaurea triumfetti lingulata* | 1 | + | . | . | . |
| *Geranium pyrenaicum* | 1 | 2 | . | . | . |
| *Cynosurus elegans* | 1 | . | . | + | . |
| *Geranium molle* | . | . | 2 | . | 1 |
| *Geranium columbinum* | . | . | 1 | . | 1 |
| *Veronica arvensis* | . | . | . | 2 | 1 |
| *Bunium alpinum* | . | . | . | 1 | + |
| *Holcus lanatus* | . | . | . | + | + |
| *Lapsana communis* | . | . | . | + | + |
| *Silene latifolia* | 1 | . | . | . | . |
| *Helleborus foetidus* | 1 | . | . | . | . |
| *Marrubium supinum* | . | 1 | . | . | . |
| *Vulpia alopecuroides* | . | 1 | . | . | . |
| *Arum italicum* | . | . | 1 | . | . |
| *Doronicum plantagineum* | . | . | + | . | . |
| *Primula elatior lofthousei* | . | . | + | . | . |
| *Ranunculus granatensis* | . | . | + | . | . |

**Localities:** 1-2: Almería: Abrucena, Prox. del Barranco del Diablo, WG1206. 3-5: Granada: Dehesa del Camarate, WG71.

**C) Meadows and pastures**

*Cirsio micranthi-Scirpetum holoschoeni* Lorite, Salazar, Cano *et* Valle *ass. nova* (Tab. 5, *holotypus* rel. n. 8)

Round-headed club rush-bed (*Scirpus holoschoenus*) accompanied by *Cirsium pyrenaicum* var. *micranthum* occurs on siliceous substrata in areas of the meso-Mediterranean thermotype, with soils drying out in summer.

This new association is endemic to the Nevadense sector, though it is rather poor in characteristic species. It is considered to be an edaphic vicariant of the *Cirsio-Holoschoenetum vulgaris* Br.-Bl. 1931 (meso-Mediterranean basophilic rush-beds).

It appears in the dominion of the Nevadense willow-alder forests (*Carici-Salicetum atrocinereae*). In drier areas it comes into contact with climatic formations, whilst in more humid areas it is related to the helophytic *Glycerio declinatae-Apietum nodiflori* communities. When a strong nitrification occurs due to increased livestock action, this community is possibly substituted by *Cirsio-Juncetum inflexi* rush-beds.

**D) Serial shrub and wood-fringe vegetation**

*Rubo ulmifolii-Coriarietum myrtifoliae* O. Bolòs 1954 variant with *Adenocarpus decorticans*

Thick, impenetrable bramble community dominated by *Rubus ulmifolius* together with numerous lianoid and climbing species, e.g. *Rosa* spp., *Lonicera peryclimenum* subsp. *hispanica, Clematis flammula, C. vitalba, Coriaria myrtifolia* and *Tamus communis.*

It surrounds and substitutes the athrocinereous willow and alder woods in middle river tracks, or appears along irrigation channels. As it appears in areas of meso-Mediterranean thermotype, thermophilous species such as *Dorycnium rectum, Salix pedicellata, Spartium junceum, Calystegia sepium, Euphorbia characias*, etc. are common. These formations are enriched in *Adenocarpus decorticans* which, although not a typical riparian species, is often linked to these bramble communities.

The *Rubo-Coriarietum myrtifoliae* has a wide distribution in non-continental Ibero-Levantine territories. This silicicolous variant is rarely seen in the Nevadense sector, being more frequent in the Filábrico district or in the vicinity to the Alpujarreño-Gadorense sector, which are characterised by higher temperatures.

As bramble patches typically surround gallery forests, they become more vigorous when the removal of tree cover increase the light regime. These thick sarmentous communities protect and offer the necessary shade for the sprouting of new trees, and their degradation mainly leads to the appearance of meso-Mediterranean rush-beds (*Cirsio micranthi-Scirpetum holoschoeni*).

There is scant information on this community. We provide the following relevé:
Locality: Granada, Narila, Río Guadalfeo, VF8390. Altitude: 980 m. Area: 30 m$^2$. Average height: 200 cm. Coverage: 100%. Characteristics of association and higher units: *Coriaria myrtifolia* 4, *Rubus ulmifolius* 2, *Spartium junceum* 2, *Tamus communis* 1, *Euphorbia characias* 1, *Brachypodium sylvaticum* 1, *Lonicera peryclimenum hispanica* +. Acidophilous variant differentials: *Adenocarpus decorticans* 2, *Salix pedicellata* 1. Accompanying species: *Clematis flammula* 1, *Dorycnium rectum* +, *Mentha suaveolens* +, *Asparagus acutifolius* +, *Equisetum ramosissimum* +.

*Rubo ulmifolii-Rosetum corymbiferae* Arnáiz *et* Rivas-Martínez *in* Arnáiz 1979 variant with *Adenocarpus decorticans* (Tab. 6)

Thick bramble communities surrounding supra-Mediterranean willow and alder woods. Lianoid, climbing and thorny species such as *Rubus ulmifolius, Crataegus monogyna, Rosa spp.*, *Lonicera peryclimenum* subsp. *hispanica, Clematis vitalba, Vitis vinifera*, etc. are predominant. Other species of climatic vegetation needing great humidity, such as *Rhamnus catharticus, Prunus insititia, Berberis vulgaris* subsp. *australis*, etc. can also appear.

This association is distributed over a large area of the peninsular Northern Sub-Plateau, reaching the southernmost boundary through the eastern Baetic province. As it develops on base-poor substrata, in the Nevadense sector it is enriched in silicicolous species, such as *Salix caprea, Alnus glutinosa, Scrophularia scorodonia, Pteridium aquilinum, Athyrium filix-foemina*, and *Adenocarpus decorticans*, which although not characteristic of the riparian vegetation, is commonly found in this community.

The ecological significance and dynamics of bramble communities within the ripicolous vegetation has been previously discussed. In this case, the only exception is that the rush-beds originated through successive degradation and belong to the supra-Mediterranean rush-beds of *Cirsio micranthi-Juncetum effusi*.

**E) Mediterranean and Euro-Siberian climactic vegetation**

*Carici camposii-Salicetum atrocinereae* Salazar, Lorite, Cano *et* Valle *ass. nova*

Tab. 5 - *Cirsio micranthi-Scirpetum holoschoeni* Lorite, Salazar, Cano *et* Valle *ass. nova.*

| Rel. number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Altitude (m) | 1000 | 1200 | 1180 | 1140 | 1150 | 1090 | 1300 | 1080 | 1250 |
| Area ($m^2$) | 8 | 60 | 15 | 15 | 20 | 12 | 30 | 40 | 24 |
| Average height (cm) | 75 | 70 | 100 | 120 | 80 | 75 | 70 | 120 | 70 |
| Cover (%) | 100 | 50 | 100 | 50 | 85 | 95 | 100 | 80 | 90 |
| Number of taxa | 9 | 16 | 14 | 15 | 14 | 12 | 20 | 24 | 22 |
| **Characteristics of association and higher units:** | | | | | | | | | |
| *Scirpus holoschoenus* | 3 | 3 | 4 | 3 | 4 | 3 | 3 | 4 | 2 |
| *Cirsium pyrenaicum micranthum* | 1 | . | 2 | 1 | 2 | + | 1 | 2 | 3 |
| *Mentha suaveolens* | 2 | 2 | 2 | 1 | 2 | + | 3 | 2 | 2 |
| *Holcus lanatus* | 1 | 1 | 1 | + | 1 | 1 | 2 | 1 | 3 |
| *Ranunculus repens* | 2 | . | + | 1 | + | . | 1 | 1 | 1 |
| *Trifolium repens* | . | 1 | . | . | . | 3 | 2 | 1 | 1 |
| *Juncus inflexus* | . | 2 | . | . | . | 2 | 1 | . | 1 |
| *Lotus uliginosus* | . | . | . | + | . | 2 | 2 | 1 | + |
| *Agrostis castellana castellana* | . | . | + | . | . | + | 2 | 1 | 2 |
| *Mentha longifolia* | . | . | . | 1 | 1 | . | 1 | . | 1 |
| *Juncus effusus subglomeratus* | . | + | . | . | . | . | 1 | . | + |
| *Rumex conglomeratus* | . | + | . | . | . | . | . | + | + |
| *Hypericum tetrapterum* | . | 1 | . | . | . | . | . | . | + |
| *Pulicaria dysenterica* | . | + | 1 | . | . | . | . | . | . |
| *Dactylorrhiza elata* | . | . | + | . | . | + | . | . | . |
| *Anthoxantum odoratum* | . | . | . | . | . | . | 2 | . | 1 |
| *Sonchus maritimus aquatilis* | . | . | . | . | . | . | + | . | + |
| *Lotus corniculatus* | . | . | . | . | . | . | . | 1 | 2 |
| **Accompanying species:** | | | | | | | | | |
| *Brachypodium sylvaticum* | . | . | . | 1 | 1 | . | 1 | 1 | 1 |
| *Medicago lupulina* | . | . | . | 1 | 2 | . | . | 1 | . |
| *Euphorbia characias* | 1 | + | . | . | . | . | . | . | . |
| *Epilobium parviflorum* | . | + | . | . | . | . | . | . | + |
| *Apium nodiflorum* | . | + | . | + | . | . | . | . | . |
| *Scrophularia scorodonia* | . | . | 1 | + | . | + | . | . | . |
| *Salix atrocinerea* | . | . | + | + | + | . | . | . | . |
| *Artemisia campestris glutinosa* | . | . | . | 1 | + | . | . | 1 | . |
| *Festuca scariosa* | . | . | . | + | + | . | . | . | . |
| *Ononis spinosa* | . | . | . | . | + | 1 | . | 1 | . |
| *Urtica dioica* | . | . | . | . | . | . | . | 1 | 1 |
| *Cirsium vulgare* | . | . | . | . | . | . | + | + | . |

**Sporadic species:** Rel. 1. *Dorycnium rectum* 2, *Trifolium pratense*, +, *Plantago major* +. Rel. 2. *Lolium perenne* 1, *Cynosurus elegans* 1, *Mantisalca salmantica* +, *Digitalis purpurea nevadensis* +. Rel. 3. *Lotus pedunculatus granadensis* 1, *Cyperus longus* 1, *Epilobium hirsutum* +, *Hypericum perforatum* +. Rel. 4. *Equisetum telmateia* +. Rel. 5. *Crepis vesicaria* 1, *Dittrichia viscosa* +. Rel. 6. *Juncus bufonius* +. Rel. 7. *Lathyrus pratensis* +, *Festuca arundinacea* +, *Carex cuprina* +, *Carex camposii* +, *Juncus subnodulosus* +. Rel. 8. *Equisetum ramosissimum* 2, *Cynodon dactylon* 1, *Mentha spicata* 1, *Veronica anagallis-aquatica* 1, *Picnomon acarna* +, *Senecio malacitanus* +, *Silene latifolia* +, *Helleborus foetidus* +. Rel. 9. *Ranunculus granatensis* +, *Salix purpurea* +, *Rubus ulmifolius* +.
**Localities:** 1: Granada: Narila, Rio Guadalfeo, VF0998. 4 and 5: Almeria: Abrucena; rio Abrucena, WG1608. 6: Almeria: Fiñana, rio Nacimiento, WG0811. 7: Granada Lugro, Rio Alhama de Lugros, VG7716. 8: Almeria: Abrucena, rio Abrucena, WG1708. 9: Granada: Lugros; Rio Alhama de Lugros, VG7716.

Tab. 6 - *Rubo ulmifolii-Rosetum corymbiferae* Rivas Martinez *et* Arnaiz *in* Arnaiz 1979 variant with *Adenocarpus decorticans*.

| Rel. number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Altitude (m) | 1120 | 1140 | 1380 | 1620 | 1200 | 1460 | 1520 | 1350 | 1440 | 1440 |
| Area ($m^2$) | 100 | 160 | 100 | 100 | 150 | 50 | 40 | 135 | 30 | 20 |
| Slope (°) | 45 | 20 | 35 | 20 | 5 | - | 10 | 5 | - | - |
| Exposition | N | O | NO | SE | S | - | S | N | - | - |
| Average height (cm) | 150 | 250 | 250 | 200 | 200 | 200 | 250 | 200 | 175 | 175 |
| Cover (%) | 100 | 90 | 100 | 100 | 75 | 90 | 100 | 100 | 80 | 75 |
| Number of taxa | 19 | 17 | 11 | 19 | 9 | 13 | 15 | 14 | 9 | 12 |
| **Characteristics of association and higher units:** | | | | | | | | | | |
| *Rubus ulmifolius* | 4 | 4 | 4 | 3 | 4 | 5 | 2 | 5 | 4 | 3 |
| *Rosa corymbifera* | 2 | 2 | 3 | 3 | 2 | 1 | 4 | 2 | . | . |
| *Crataegus monogyna* | 3 | 3 | . | 3 | 1 | . | . | . | 1 | 2 |
| *Hedera helix* | 2 | . | + | 1 | . | 1 | . | . | . | + |
| *Rosa canina* | 1 | 1 | . | . | . | . | . | . | 2 | + |
| *Salix atrocinerea* | . | . | 1 | . | 1 | . | . | . | + | 2 |
| *Lonicera periclymenum hispanica* | . | . | . | 2 | . | 1 | . | . | . | + |
| *Berberis vulgaris australis* | . | . | . | . | . | 2 | 1 | . | 1 | . |
| *Rosa pouzinii* | 1 | 1 | . | . | . | . | . | . | . | . |
| **Acidophilous variant differentials** | | | | | | | | | | |
| *Adenocarpus decorticans* | + | 2 | 1 | 1 | 2 | 1 | 1 | + | 1 | 1 |
| *Athyrium filix-foemina* | . | + | . | + | . | . | + | . | . | 1 |
| *Pteridium aquilinum* | . | . | . | 1 | . | 1 | + | 2 | . | . |
| **Accompanying species:** | | | | | | | | | | |
| *Helleborus foetidus* | + | + | . | 1 | 1 | + | + | 1 | + | . |
| *Euphorbia characias* | . | . | + | + | 1 | + | 1 | . | . | . |
| *Brachypodium sylvaticum* | + | . | 1 | 1 | . | . | . | . | . | . |
| *Alnus glutinosa* | . | . | . | . | . | . | . | . | 2 | 1 |
| *Urtica dioica* | . | . | + | 1 | . | 1 | 1 | 1 | . | . |
| *Rubia peregrina* | 1 | + | + | . | . | 1 | . | . | . | . |
| *Scrophularia scorodonia* | + | . | 1 | . | + | . | + | . | . | . |
| *Mentha suaveolens* | . | . | . | . | + | + | + | 1 | . | . |
| *Festuca scariosa* | + | + | + | . | . | . | . | . | . | . |
| *Ballota hirsuta* | 1 | + | . | . | . | . | . | . | . | . |
| *Helichrysum italicum serotinum* | + | + | . | . | . | . | . | . | . | . |
| *Asparagus acutifolius* | + | + | . | . | . | . | . | . | . | . |
| *Cirsium pyrenaicum micranthum* | + | . | . | . | . | . | . | + | . | . |
| *Geranium purpureum* | . | . | . | + | . | . | + | . | . | . |
| *Hypericum tetrapterum* | . | . | . | + | . | . | 1 | . | . | . |
| *Holcus lanatus* | . | . | . | + | . | . | . | 1 | . | . |
| *Rumex conglomeratus* | . | . | . | . | . | . | + | + | . | . |

**Sporadic species:** Rel. 1. *Populus nigra italica* 1, *Rumex induratus* +, *Artemisia campestris glutinosa* +. Rel.2. *Quercus rotundifolia* 1, *Ptilostemon hispanicus* +, *Thymus mastichina* +, *Cytisus grandiflorus* +. Rel. 4. *Prunus ramburii* 1, *Juglans regia* +, *Peucedanum hispanicum* +, *Festuca elegans* +. Rel. 6. *Campanula rapunculus* +. Rel. 7. *Cirsium pyrenaicum longespinosum* +. Rel. 8. *Sonchus maritimus aquatilis* +, *Ranunculus repens* +, *Agrostis canina canina* 1, *Equisetum ramossisimum* +. Rel. 9. *Prunus spinosa* 1. Rel. 10. *Clematis vitalba* +, *Rosa micrantha* +, *Rhamnus catharticus* +.

**Localities:** 1 and 2: Almeria: Abrucena, rio Abrucena, WG1507. 3: ibidem; Barranco de la Mina, WG1506. 4: Almeria: Laujar de Andarax, Barranco de los Tejos, WG0403. 5: Almeria: Bayácal, Arroyo del Palancón, VF9999. 6 and 7: Almeria: Beires, rio Ohanes, WG1801. 8: Granada: Lugros, rio Alhama de Lugros, VG7716. 9 and 10: Granada: Arroyo Alhori, VG8312.

Tab. 7 - *Carici camposii-Salicetum atrocinereae* Salazar, Lorite, Cano *et* Valle *ass. nova*

| Rel. number | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Altitude (m, x 10) | 146 | 160 | 120 | 140 | 160 | 185 | 168 | 164 | 144 | 115 | 155 | 122 | 150 | 170 | 170 | 162 | 100 | 150 |
| Area ($m^2$) | 100 | 150 | 100 | 100 | 125 | 60 | 200 | 160 | 160 | 100 | 150 | 125 | 125 | 75 | 200 | 150 | 150 | 60 |
| Average height (cm) | 400 | 600 | 500 | 200 | 900 | 300 | 250 | 900 | 900 | 900 | 900 | 800 | 400 | 900 | 600 | 600 | 600 | 300 |
| Cover (%) | 90 | 80 | 100 | 100 | 100 | 100 | 100 | 100 | 75 | 90 | 80 | 75 | 75 | 60 | 100 | 90 | 90 | 100 |
| Number of taxa | 20 | 26 | 14 | 24 | 15 | 22 | 18 | 21 | 16 | 24 | 19 | 14 | 18 | 13 | 23 | 22 | 31 | 38 |
| **Characteristics of assoc. and higher units:** | | | | | | | | | | | | | | | | | | |
| *Salix atrocinerea* | 4 | 4 | 3 | 5 | 2 | 4 | 4 | 4 | 3 | 2 | 3 | 3 | 3 | 3 | 4 | 4 | 2 | 4 |
| *Carex camposii* | 2 | + | + | 1 | 2 | 1 | 1 | 1 | . | . | 2 | + | 1 | . | 2 | 1 | + | 1 |
| *Alnus glutinosa* | . | . | 4 | . | 5 | . | . | 4 | 2 | 1 | 4 | 3 | . | . | 3 | . | . | + |
| *Athyrium filix-foemina* | 3 | + | 1 | . | 1 | 2 | 1 | . | 1 | 1 | + | . | 2 | 2 | 2 | 1 | 2 | 1 |
| *Brachypodium sylvaticum* | 1 | 2 | . | 2 | 1 | . | 1 | 2 | . | + | 1 | 1 | . | . | . | . | + | 2 |
| *Scrophularia scorodonia* | + | . | . | . | . | + | + | . | . | + | 1 | + | . | . | + | + | 1 | . |
| *Hedera helix* | . | 1 | + | . | 1 | . | . | 2 | + | . | . | . | . | . | 1 | + | 1 | 1 |
| *Helleborus foetidus* | . | . | . | + | 1 | . | + | 1 | . | 1 | + | . | . | . | . | 1 | + | 1 |
| *Euphorbia characias* | . | . | 1 | 1 | . | . | . | . | . | + | . | . | . | . | + | . | + | 1 |
| *Populus x canadensis* | . | 3 | 1 | . | . | . | . | 2 | . | . | 2 | 2 | . | . | . | . | . | . |
| *Populus nigra italica* | . | . | . | 1 | . | . | . | . | 2 | . | 2 | . | . | . | . | . | 2 | 2 |
| *Lapsana communis* | . | . | . | . | . | + | + | . | . | + | + | . | . | . | . | + | . | . |
| *Poa nemoralis* | 1 | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | . | + |
| *Tamus communis* | . | . | . | . | . | . | . | . | . | 1 | . | + | . | . | . | . | . | + |
| *Clinopodium vulgare* | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | + |
| *Origanum vulgare* | . | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | + | . |
| *Salix x quercifolia* | . | . | . | . | . | 1 | . | . | . | . | . | 2 | . | . | . | . | . | . |
| *Geum urbanum* | . | . | . | . | . | . | . | 1 | . | . | . | . | 1 | . | . | . | . | . |
| *Sorbus aucuparia* | . | . | . | . | . | . | . | . | + | . | 1 | . | . | . | . | . | . | . |
| *Salix fragilis* | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | . | 1 | . |
| *Origanum virens* | . | . | . | . | . | . | . | . | . | + | . | + | . | . | . | . | . | . |
| **Differentials of subass. *salicetosum capreae*:** | | | | | | | | | | | | | | | | | | |
| *Prunus avium* | . | . | . | . | . | . | . | . | . | . | . | . | 1 | 1 | + | . | 1 | + |
| *Salix caprea* | . | . | . | . | . | . | . | . | . | . | . | . | 3 | 2 | . | 2 | . | . |
| *Lonicera arborea* | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | + |
| *Acer opalus granatense* | . | . | . | . | . | . | . | . | . | . | . | . | 2 | 2 | . | . | . | . |
| *Sorbus aria* | . | . | . | . | . | . | . | . | . | . | . | . | 2 | 2 | . | . | . | . |
| *Betula pendula fontqueri* | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | . | . | . | . |
| *Rhamnus catharticus* | . | . | . | . | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . |
| **Accompanying species** | | | | | | | | | | | | | | | | | | |
| *Rubus ulmifolius* | + | 2 | 1 | 1 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | . | 1 | 2 | 2 | 2 |
| *Crataegus monogyna* | . | . | . | . | 1 | 2 | 1 | . | 2 | . | 2 | . | . | 1 | 1 | 1 | . | . |
| *Rosa corymbifera* | + | . | 1 | . | . | . | 2 | . | . | . | . | . | . | + | . | + | . | . |
| *Lonicera periclymenum hispanica* | . | . | . | . | + | 1 | . | . | + | 1 | . | . | . | . | + | . | . | . |
| *Berberis vulgaris australis* | . | . | . | . | . | + | + | . | . | . | . | . | . | 1 | . | + | . | . |
| *Pteridium aquilinum* | . | . | . | . | . | . | . | . | . | + | . | 2 | 1 | . | . | . | 1 | . |
| *Rosa pouzinii* | . | 1 | . | + | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 |
| *Rosa canina* | . | . | . | . | . | . | . | . | + | . | 1 | . | . | . | . | 1 | . | . |
| *Clematis vitalba* | . | . | . | . | . | . | . | . | + | . | . | + | . | . | . | . | 1 | . |
| *Spartium junceum* | . | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | + | . |

Tab. 7 - Continued.

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Accompanying species:** | | | | | | | | | | | | | | | | | | |
| *Holcus lanatus* | . | 2 | 1 | 1 | . | 1 | 1 | 1 | . | + | 1 | . | 1 | . | 1 | 1 | + | 1 |
| *Urtica dioica* | + | 1 | . | . | 1 | 2 | 1 | 2 | . | 2 | . | . | . | . | 2 | 2 | . | + |
| *Digitalis purp. nevadensis* | . | + | . | + | . | + | . | + | . | + | + | + | . | . | + | . | + | + |
| *Peucedanum hispanicum* | 1 | 2 | 1 | 1 | . | . | . | . | + | . | 1 | . | . | . | 2 | . | + | 1 |
| *Adenocarpus decorticans* | . | . | . | . | + | 1 | 1 | . | 1 | . | 1 | + | . | . | . | + | 1 | 1 |
| *Hypericum tetrapterum* | + | . | . | + | + | . | . | . | . | . | . | . | + | . | + | . | + | + |
| *Cochlearia megalosperma* | . | 1 | . | . | . | . | + | 1 | + | . | . | . | + | + | + | . | . | . |
| *Geranium purpureum* | . | + | . | . | . | + | + | + | . | + | . | . | . | . | 1 | . | . | . |
| *Scirpus holoschoenus* | + | + | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | + |
| *Epilobium parviflorum* | + | 1 | . | + | . | . | . | . | . | + | . | . | . | . | . | . | . | . |
| *Senecio jacobaea* | + | . | . | . | . | 2 | . | . | . | . | + | . | . | . | . | 1 | . | . |
| *Lotus uliginosus* | 1 | . | . | + | . | . | . | 1 | . | . | . | . | . | . | . | . | . | + |
| *Mentha suaveolens* | 1 | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | + | + |
| *Ranunculus granatensis* | . | . | . | 1 | . | . | . | 1 | . | . | . | . | . | . | . | + | + | . |
| *Cardamine flexuosa* | . | . | . | . | . | . | . | . | . | + | . | . | . | . | + | . | 1 | + |
| *Dactylorrhiza elata* | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + |
| *Cytisus grandiflorus* | . | + | + | . | . | . | . | 2 | . | . | . | . | . | . | . | . | . | . |
| *Mentha longifolia* | . | + | . | 1 | . | . | . | . | . | . | . | . | . | . | . | 1 | . | . |
| *Prunella vulgaris* | . | . | . | + | . | . | . | . | . | . | . | . | . | . | . | + | . | + |
| *Juncus inflexus* | . | . | . | + | . | . | . | . | . | . | . | . | + | . | . | . | . | + |
| *Myosotis decumbens teresiana* | . | . | . | . | . | + | . | . | . | . | . | . | + | . | . | . | . | + |
| *Ranunculus repens* | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | 1 | . | . | + |
| *Trifolium repens* | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . |
| *Sonchus marit. aquatilis* | . | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + |
| *Heracleum sphondylium granatense* | . | . | . | + | . | . | . | . | + | . | . | . | . | . | . | . | . | . |
| *Dryopteris filix-mas* | . | . | . | . | . | 1 | . | . | . | . | . | . | . | . | . | . | + | . |
| *Cirsium pyrenaicum microanthum* | . | . | . | . | . | + | . | . | . | . | . | . | + | . | . | . | . | . |
| *Carex cuprina* | . | . | . | . | . | . | 1 | 1 | . | . | . | . | . | . | . | . | . | . |
| *Trifolium pratense* | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | . | . | . | + |
| *Tanacetum parthenium* | . | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | + | . |
| *Rubia peregrina* | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | . | . | 1 |
| *Ficus carica* | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + |

**Sporadic species:** Characteristics of class: Rel. 4. *Asplenium onopteris* +. Rel. 5. *Viola suavis* +. Rel. 6. *Populus tremula* 1, *Fraxinus angustifolia angustifolia* 1, *Rosa montana* 2. Rel. 10. *Castanea sativa* 2. Rel. 15. *Rosa micrantha* 1. Rel. 18. *Quercus pyrenaica* +, *Equisetum temalteia* 1. Accompanying species: Rel.1. *Anthoxantum odoratum* 1, *Festuca arundinacea* +. Rel. 2. *Lathyrus pratensis* 1, *Agrimonia eupatoria* 1, *Festuca elegans* +, *Agrostis castellana castellana* +, *Viola reichembachiana* +, *Rumex conglomeratus* +,. Rel. 3. *Equisetum ramossisimum* +, *Scrophularia canina canina* +. Rel. 5. *Cistus laurifolius* +. Rel. 6. *Anthriscus sylvestris* +. Rel. 7. *Potentilla reptans* +. Rel. 10. *Apium nodiflorum* +, *Parietaria judaica* +. Rel. 14. *Aconitum burnatii* +. Rel. 15. *Aquilegia vulgaris nevadensis* 1. Rel. 17. *Bupleurum fruticosum* 2, *Agrostis stolonifera* +, *Trachelium caeruleum* +.

**Localities**: 1: Almería: Beires, Río Ohanes, WG1801. 2: Almería: Fiñana, Arroyo de Lubeire, WG6808. 3: Almería: Laujar de Andarax, Río Andarax, WF0999. 4:Granada: Capileira, afluente del Poqueira, VF6891. 5: Granada: Aldeire, barranco de los Tejos, VG9308. 6: Granada: Río Barrio, VG8708. 7: Almería: Ohanes, Arroyo de Tices, WG1904. 8: Granada: Aldeire, arroyo de los Pasillos, VG9309. 9: Granada: Jeres del Marquesado, arroyo del Alhorí, VG3812. 10: Granada: Bérchules, río Guadalfeo, VF8391. 11: Granada: Lanteira, Río Pueblo, VG8610. 12: Granada: Río Alhama de Lugros, VG7819. 13: Granada: Dehesa del Camarate, VG7715. 14: Granada: Dehesa del Camarate, barranco de las Rozas, VG7614. 15: Almería: Bayárcal, Arroyo Anchuelo, WG0002. 16: Granada: Río Barrio, VG8809. 17: Granada: Río Bermejo, VF7188. 18: Granada: Las Cebadillas, Arroyo afluente Poqueira, VF6894.

subas. *salicetosum atrocinereae* (Tab. 7, rels. 1-12. *holotypus* rel. n. 11)
subas. *salicetosum capreae* (Tab. 7, rels. 13-18. *holotypus* rel. n. 13)

Thick, athrocinereous willow and alder forests developed on siliceous materials along streams of oligotrophic, permanently-flowing waters. Their optimum is found in very deep gullies of the subhumid supra-Mediterranean, descending to the meso-Mediterranean thermotype, where they become blurred because of the strong anthropic action.

Alder (*Alnus glutinosa*) is the predominant species of this community when it occurs in close vicinity of running water, however the greater part of the biomass is more frequently formed by *Salix atrocinerea*. Other willows (e.g. *Salix fragilis*) and poplar trees (*Populus nigra, P. tremula*) may also be present. The species of the shrub and herbaceous layers which better characterise these alder forests are *Athyrium filix-foemina, Scrophularia scorodonia* (typical of the alliance *Osmundo-Alnion*), *Adenocarpus decorticans* (very common in the Nevadense sector), *Digitalis purpurea* subsp. *nevadensis* and *Carex camposii* (endemic). The deep shade and humidity of these environments allows for the growth of several ferns (*Athyrium filix-foemina, Pteridium aquilinum, Dryopteris filix-mas*, etc.).

The alder-tree forests of Sierra Nevada have been considerably altered by man, and it is often difficult to find well developed, typical stands. In several studies on the vegetation of the Nevadense massif they seem to have been neglected. The existence of alder forests along the Nevadense riversides has even been denied by Martínez-Parras *et al.* (1987a, 1987c). In other areas alder forests are probably of anthropic origin, but there are some evidences supporting their indigenate in Sierra Nevada. For instance, the anthracitic remains found in the Millares site, which date back to the Copper Age, can have no other origin than the forests along the streams and rivers of the study area. At the same time, on the northern slope of this massif there are a few toponyma related to alder (Los Alisares of the Pueblo River, the Aliso gully in the Granada Alpujarra, etc). Certainly in the past alder was much more abundant than now, and nowadays a large part of alder forests can be interpreted as relictual. However, they should be considered as the climax of the Nevadense supra- and meso-Mediterranean riparian vegetation.

Contrary to alder forests, athrocinereous willow communities have often been reported by previous authors (Losa-Quintana *et al.* 1986, 1987; Martínez-Parras *et al.* 1987a; Molero-Mesa 1988; Pérez-Raya *et al.* 1990; Molero-Mesa *et al.* 1992 and Salinas & Blanca 1996), generically referred to as "*Salix atrocinerea* communities" without any precise syntaxonomic arrangement, and in the majority of cases even without the provision of phytosociological relevés.

The new association seems to be endemic to the Nevadense sector, where it is widely distributed, and is fragmentary in the Filábrico district due to the lower water level of its streams. The characteristic physiognomy of these communities, the existence of some relevés with a strong dominance of alder and the presence (sometimes with low cover values) of species characteristic of *Osmundo-Alnion* (*Alnus glutinosa, Salix atrocinerea, Scrophularia scorodonia, Athyrium filix-foemina*) has led us to include the new association in the latter alliance, and more particularly in the *Osmundo-Alnenion* suballiance, which was previously restricted to the Ibero-Atlantic province. Due to its isolation in relation to other alder forests of the suballiance, the new association can be regarded as very poor, even lacking typical taxa such as *Osmunda regalis, Clematis campaniflora, Galium broterianum* or *Carex broteriana*. The Nevadense athrocinereous willow and alder-tree communities have been characterised by *Carex camposii*, a faithful taxon to the herbaceous substratum present in both the meso- and supra-Mediterranean belts.

The *salicetosum capreae* subassociation develops in more humid situations (generally within the subhumid dominion of the mesophytic Pyrenean oak series) as on the northern slope of the Nevadense district. Interesting and rare taxa are present, such as *Prunus avium, Betula pendula* subsp. *fontqueri, Salix caprea, Acer opalus* subsp. *granatense, Taxus baccata, Sorbus aria, Lonicera arborea, Rhamnus catharticus*, etc. For floristic and biogeographical reasons, this syntaxon can be properly considered a subassociation and not a simple ecological variant typical of the Nevadense district but absent from the Filábrico district.

The degradation of these gallery forests changes the ecological conditions, with the bramble community taking advantage. The following modifications are noteworthy: reduction in the pteridoflora, regression of *Origanetalia vulgaris* communities and increase of *Agropyro-Rumicion* species as a result of increased light condition and more frequent livestock access.

This association comes into contact with numerous herbaceous communities such as rush-beds (*Cirsio micranthi-Juncetum effusi*), megaforbic communities (*Aquilegio-Ranunculetum granaten-*

*sis, Ranunculo-Cochlearietum megalospermae*), helophytic formations (*Caricetum camposii-cuprinae*) and nitrophilous vegetation.

## Conclusions

In the past the phytosociological studies on the hygrophilous vegetation of Sierra Nevada had traditionally been limited to pastures, peat-bogs, and streams of the upper bioclimatic belts (oro-Mediterranean and cryoro-Mediterranean).

In this study we discussed some interesting plant communities, developed mainly in areas of the meso-Mediterranean and supra-Mediterranean thermotypes but reaching in some cases the oro-Mediterranean, which had been completely ignored, or had been only briefly discussed by previous authors.

The following syntaxa (four associations, two subassociations, two variants and one community) needed to be described as new:

1. *Caricetum camposii-cuprinae* Salazar, Lorite, Cano *et* Valle *ass.* nova
2. *Ranunculo granatensis-Cochlearietum megalospermae* Salazar, Lorite, Cano *et* Valle *ass. nova*
3. *Cirsio micranthi-Scirpetum holoschoeni* Lorite, Salazar, Cano *et* Valle *ass. nova*
4. *Carici camposii-Salicetum atrocinereae* Salazar, Lorite, Cano *et* Valle *ass. nova*
5. *Myrrhoidi nodosae-Alliarietum petiolatae* Rivas-Martínez *et* Mayor *ex* V. Fuente 1986 *nepetosum granatensis subass. nova*
6. *Carici camposii-Salicetum atrocinereae salicetosum capreae* Salazar, Lorite, Cano *et* Valle *subass. nova*
7. *Rubo ulmifolii-Coriarietum myrtifoliae* O. Bolòs 1954 variant with *Adenocarpus decorticans*
8. *Rubo ulmifolii-Rosetum corymbiferae* Arnáiz *et* Rivas-Martínez *in* Arnáiz 1979 variant with *Adenocarpus decorticans*
9. *Cratoneuron commutatum* and *Anagallis tenella* community

The majority are endemic to the Nevadense sector, and are better developed in the Nevadense district. They have an important rate of relict and endemic species, and host several species with an arctic-alpine disjunction.

A suitable interpretation of the vegetation dynamics of these little-known plant communities, which usually occur in fragile, endangered environments, should be considered of major interest. With this knowledge, it will be possible to carry out an accurate study of the Nevadense vegetation series and geoseries and to offer possible solutions for its restoration.

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# DUE NUOVE ASSOCIAZIONI DI MARGINE STRADALE DELL'ABRUZZO (ITALIA CENTRALE)

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**Keywords:** Abruzzo, Italy, roadside vegetation.

**Abstract:** Two new associations of roadside vegetation from Abruzzo (Central Italy). This study describes the perennial nitrophilous and meso-igrophilous vegetation, occurring along the main roads of Abruzzo up to 900 m a.s.l. Two roadside phytocoenoses are described, one with *Senecio inaequidens* and the other with *Plumbago europaea*. They are attributed to two new associations of the *Artemisietea vulgaris* class, *Artemisio absinthii-Senecionetum inaequidentis*, belonging to the *Dauco-Melilotion* alliance (*Onopordetalia acanthii* order) and *Galio albi-Plumbaginetum europaeae*, belonging to the *Inulo viscosae-Agropyrion repentis* alliance (*Agropyretalia repentis* order).

## Introduzione

La presente ricerca ha per oggetto alcuni aspetti della vegetazione di margine delle strade statali e provinciali dell'Abruzzo e dei territori confinanti del Molise.

I dati di letteratura relativi a questo tipo di vegetazione, con riferimento alle regioni adriatiche dell'Italia appenninica, sono piuttosto frammentari e riguardano soprattutto le comunità vegetali delle strade di campagna e delle aree urbanizzate, dove il suolo viene rimosso periodicamente e si affermano fitocenosi afferenti in modo preponderante alle classi *Stellarietea mediae* e *Molinio-Arrhenatheretea* (ordine *Plantaginetalia majoris*), e solo in minor misura alla classe *Artemisietea vulgaris*. Ne sono esempi le associazioni *Rumici-Carduetum pycnocephali, Hordeetum murini, Aveno barbatae-Brometum diandri* per le Marche (Hruska 1985, 1989, 1998; Biondi & Baldoni 1991); *Lolio-Plantaginetum, Hordeetum murini, Brometum sterilis, Aveno-Brometum diandri, Diplotaxi tenuifoliae-Agropyretum repentis* per l'Abruzzo (Fascetti & Veri 1983; Pirone & Ferretti 1999). La vegetazione indagata in questo studio è al contrario condizionata dagli interventi di manutenzione delle strade, consistenti in particolare nello sfalcio periodico. Questa pratica, assieme alla buona disponibilità idrica dell'habitat favorita dal transito veicolare e dalle cunette laterali di drenaggio, permette l'affermazione di un elevato numero di piante perennanti (emicriptofite, geofite e camefite) a carattere più o meno nitrofilo e mesoigrofilo, il cui massimo sviluppo viene raggiunto in autunno.

Il presente studio vuole contribuire, quindi, a colmare le lacune relative agli aspetti più mesofili e nitrofili della vegetazione dei margini stradali.

## Materiali e metodi

Lo studio è stato condotto con il metodo fitosociologico (Braun-Blanquet 1964). I rilievi sono stati eseguiti in un intervallo altitudinale compreso tra 0 e 900 m circa nel periodo autunnale (settembre-ottobre), quando questa vegetazione presenta la massima espressività sia vegetativa che antesica.

Gli spettri biologici e corologici ponderati sono stati calcolati servendosi dell'indice di ricoprimento specifico, che esprime e valuta per ciascuna specie presente nella tabella fitosociologica la sua copertura nell'ambito dell'associazione. Esso si calcola sommando i valori centrali degli indici di abbondanza-dominanza, dividendo per il numero di rilievi della tabella e moltiplicando questo valore per 100 (Braun-Blanquet 1964; Pirola 1970).

La nomenclatura delle specie è, salvo eccezioni, quella riportata in Pignatti (1982).

## Risultati

Nel territorio indagato la vegetazione lungo le strade si distingue, sul piano ecologico-floristico, in due tipologie di cui una è a diretto contatto con la sede stradale asfaltata ed è formata da una stretta fascia pianeggiante, l'altra è insediata lungo il ver-

sante oltre la cunetta (Fig. 1).

Il seguente schema chiarisce la posizione sintassonomica delle fitocenosi descritte.

*Artemisietea vulgaris* Lohm., Prsg. & Tx. 1950 ampl. Riv.-Mart. *et alii* 1991

*Onopordetalia acanthii* Br.-Bl. & Tx. 1943 em. Goers 1966

*Dauco-Melilotion* Goers 1966

*Artemisio absinthii-Senecionetum inaequidentis* ass. *nova*

*Agropyretalia repentis* (Oberd. *et alii* 1967) Muell. & Goers 1969

*Inulo viscosae-Agropyrion repentis* Biondi & Allegrezza 1996

*Galio albi-Plumbaginetum europeae* ass. *nova*

*elytrigetosum athericae* subass. *nova*

*elytrigetosum repentis* subass. *nova*

***Artemisio absinthii-Senecionetum inaequidentis*** ass. nova

La fisionomia della vegetazione a contatto con la sede stradale è conferita principalmente da *Senecio inaequidens* e, in secondo luogo, da *Artemisia absinthium, A. vulgaris, Diplotaxis tenuifolia* e *Achillea collina*.

*Senecio inaequidens* è una neofita originaria del Sudafrica, osservata per la prima volta in Italia presso Verona nel 1947 (Pignatti 1982) e diffusasi rapidamente in tutto il centro-nord. In Abruzzo è stata osservata per la prima volta negli anni '70 (Anzalone 1976) ed è diventata comune negli ambienti ruderali e nelle aree incolte (Tammaro & Pirone 1980; Guarrera e Tammaro 1994; Conti 1998; osservazioni inedite dell'Autore). Nel territorio indagato la vegetazione meglio caratterizzata da *Senecio inaequidens* è quella dei margini delle strade, dove spesso domina nettamente e si comporta, generalmente, da camefita suffruticosa. Le pratiche di manutenzione dei margini stradali favoriscono il mantenimento nel tempo di questa particolare comunità vegetale che costituisce, quindi, un aspetto peculiare ed affermato della vegetazione legata a tale tipo di habitat a determinismo antropico.

Per questa vegetazione, sulla base dei rilievi di Tab. 1, viene proposta una nuova associazione denominata *Artemisio absinthii-Senecionetum inaequidentis* (rilievo tipo n. 5 di Tab. 1), di cui si indicano come specie caratteristiche e differenziali *Senecio inaequidens, Polygonum aviculare, Cynodon dactylon, Verbascum sinuatum* e *Onobrychis viciifolia*. In particolare, *Polygonum, Cynodon* e *Verbascum* sottolineano il disturbo legato al calpestio. La vegetazione raggiunge l'optimum di sviluppo in autunno.

L'associazione viene inquadrata nell'alleanza *Dauco-Melilotion* e nell'ordine *Onopordetalia acanthii*, che riuniscono le vegetazioni ruderali termoxerofile da bienni a perenni, legate a suoli scarsamente o mediamente dotati di nitrati (Poldini 1989).

Come proposto da alcuni Autori, la vegetazione nitrofila e subnitrofila perenne viene riunita nella classe *Artemisietea vulgaris*, a distribuzione eurosiberiana, che penetra frequentemente nella regione mediterranea, su suoli freschi e ricchi in sostanza organica.

L'associazione è caratterizzata da un buon livello di mesofilía, sottolineata dal contingente di specie della classe *Molinio-Arrhenatheretea (Dactylis glomerata, Taraxacum officinale, Plantago lanceolata, Arrhenatherum elatius*, ecc.), favorito dal periodico sfalcio della vegetazione per manutenzione e dall'acqua proveniente dalla sede stradale durante i periodi di pioggia.

I rilievi dal n. 4 al n. 10 sono più ricchi di specie della classe *Stellarietea mediae* e sottolineano un più marcato rapporto con la vegetazione di questo sintaxon.

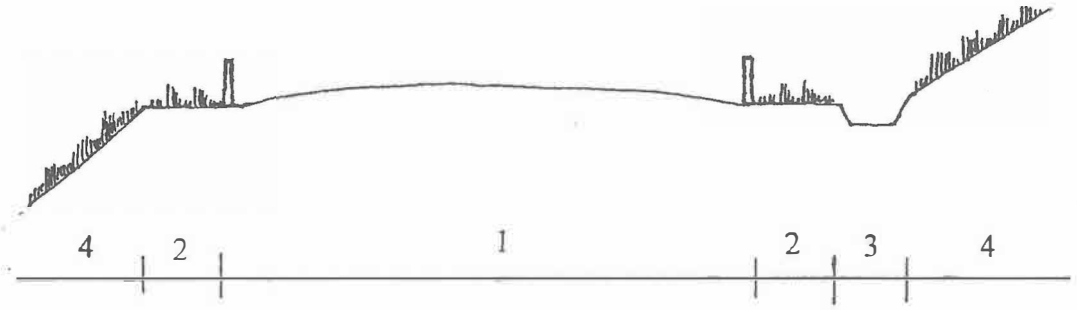


Fig. 1 - Disposizione, lungo i margini stradali, della vegetazione studiata. 1: sede stradale; 2: *Artemisio absinthii-Senecionetum inaequidentis*; 3: cunetta; 4: *Galio albi-Plumbaginetum europaeae*.

*Schematic diagram of the distribution of the two phytocoenoses along a road section. 1: road; 2:* Artemisio absinthii-Senecionetum inaequidentis*; 3: margin; 4:* Galio albi-Plumbaginetum europaeae.

Tab. 1 - *Artemisio absinthii - Senecionetum inaequidentis* ass. nova.

| Elemento corologico | Forma biologica | N. del rilievo | 1 | 2 | 3 | 4 | 5* | 6 | 7 | 8 | 9 | 10 | PRESENZA | CLASSE DI PRESENZA | Indice di ricopr. specif. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Altitudine (m) | 800 | 140 | 570 | 645 | 670 | 670 | 470 | 765 | 740 | 570 | | | |
| | | Esposizione | - | - | - | - | - | - | - | - | - | - | | | |
| | | Inclinazione (°) | - | - | - | - | - | - | - | - | - | - | | | |
| | | Copert. vegetaz. (%) | 100 | 90 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | | | |
| | | Superf. rilev. (mq) | 4 | 10 | 20 | 5 | 3 | 4 | 3 | 6 | 3 | 25 | | | |
| **Car. e diff. di associazione** | | | | | | | | | | | | | | | |
| Sudafrica (nat.) | Ch suffr | Senecio inaequidens | 3 | 4 | 4 | 4 | 4 | 3 | 4 | 3 | 3 | 4 | 10 | V | 5250 |
| Cosmop. | T rept | Polygonum aviculare | . | + | 1 | 1 | + | + | . | . | + | + | 7 | IV | 100 |
| Cosmop. | G rhiz | Cynodon dactylon | . | 2 | . | 1 | 1 | . | + | . | . | 1 | 5 | III | 235 |
| Euri-Medit. | H bienn | Verbascum sinuatum | . | + | + | . | . | . | . | + | . | + | 4 | II | 40 |
| Medit.-Mont. | H scap | Onobrychis viciifolia | . | . | . | . | + | . | . | + | + | . | 3 | II | 30 |
| **Car. *Dauco-Melilotion/Onopordetalia acanthii*** | | | | | | | | | | | | | | | |
| Eurosib. | H scap | Picris hieracioides | . | 2 | + | 1 | + | 1 | . | 2 | + | + | 8 | IV | 390 |
| Paleotemp. | H bienn | Daucus carota | 1 | . | + | . | + | + | . | + | + | + | 7 | IV | 85 |
| Circumbor. | H scap | Artemisia vulgaris | 2 | . | . | + | 2 | 1 | 2 | . | . | 2 | 6 | III | 635 |
| Subcosmop. | Ch suffr | Artemisia absinthium | . | . | 2 | 2 | 1 | 1 | 2 | . | . | + | 6 | III | 510 |
| Eurasiat. | H scap | Linaria vulgaris | . | . | . | . | + | + | . | + | . | . | 3 | II | 30 |
| S-Medit. | H scap | Foeniculum vulgare | . | 1 | . | . | . | . | + | . | . | . | 2 | I | 35 |
| Cosmopol. | H scap | Cichorium intybus | . | 1 | . | . | . | . | . | . | . | . | 1 | I | 25 |
| Europ. | H scap | Reseda lutea | . | . | . | . | . | . | . | . | . | r | 1 | I | 10 |
| Europ. | H bienn | Pastinaca sativa ssp. urens | . | . | + | . | . | . | . | . | . | . | 1 | I | 10 |
| **Car. *Artemisietea vulgaris*** | | | | | | | | | | | | | | | |
| C-Europ. | H bienn | Anthemis tinctoria | 1 | 1 | . | . | 1 | . | + | 2 | + | + | 7 | IV | 255 |
| Submedit.-Subatl. | H scap | Diplotaxis tenuifolia | . | . | 3 | . | 1 | 1 | . | . | 1 | . | 4 | II | 450 |
| SE-Europ. | H scap | Achillea collina | . | . | . | 2 | 1 | 2 | . | . | . | 1 | 4 | II | 350 |
| Asia orient. (nat.) | H scap | Artemisia verlotorum | . | 1 | . | 1 | 2 | . | . | 1 | . | . | 4 | II | 225 |
| Paleotemp. | G rhiz | Convolvulus arvensis | . | . | . | + | + | + | . | . | . | + | 4 | II | 40 |
| Subcosmop. | H scap | Rumex crispus | . | . | . | + | . | + | . | + | . | 1 | 4 | II | 55 |
| Paleotemp. | H scap | Silene alba | + | . | . | + | . | + | . | . | . | . | 3 | II | 30 |
| Paleotemp. | H scap | Verbena officinalis | . | . | . | . | . | . | 1 | 1 | . | + | 3 | II | 60 |
| Euri-Medit. | G rhiz | Sambucus ebulus | . | . | . | + | . | + | . | . | . | . | 2 | I | 20 |
| Circumbor. | G rhiz | Elytrigia repens | . | . | . | . | + | . | . | . | + | . | 2 | I | 20 |
| Subpontica | H scap | Chondrilla juncea | . | . | . | . | + | + | . | . | . | . | 2 | I | 20 |
| Circumbor. | G rhiz | Equisetum ramosissimum | . | + | . | 1 | . | . | . | . | . | . | 2 | I | 35 |
| Euri-Medit. | H scap | Ballota nigra | . | . | . | . | . | . | 1 | . | . | . | 1 | I | 25 |
| Eurasiat. | G rad | Cirsium arvense | . | . | . | . | . | . | . | + | . | . | 1 | I | 10 |
| Subpontica | H scap | Althaea cannabina | . | . | . | . | + | . | . | . | . | . | 1 | I | 10 |
| Steno-Medit. | G rad | Plumbago europaea | . | . | . | + | . | . | . | . | . | . | 1 | I | 10 |
| Steno-Medit. | G rhiz | Arundo pliniana | . | + | . | . | . | . | . | . | . | . | 1 | I | 10 |
| Eurosiber. | H scap | Saponaria officinalis | . | . | . | . | . | . | . | . | . | + | 1 | I | 10 |
| **Car. *Stellarietea mediae*** | | | | | | | | | | | | | | | |
| Euri-Medit. | T scap | Bromus diandrus | . | . | . | + | 1 | 1 | 1 | 2 | 2 | 1 | 7 | IV | 410 |
| Eurosib. | T scap | Malva sylvestris | . | + | 2 | + | 1 | 1 | . | . | + | 1 | 7 | IV | 255 |
| Euri-Medit.-S-Siber. | T scap | Lactuca serriola | . | . | . | + | . | + | + | + | + | + | 6 | III | 60 |
| Euri-Medit. | T scap | Avena barbata | . | . | . | + | + | 1 | + | . | 1 | + | 6 | III | 90 |
| Subcosmop. | T scap | Erodium cicutarium | . | . | 1 | . | . | + | . | + | + | . | 4 | II | 55 |
| Europ. | H bienn | Echium vulgare | . | . | . | . | + | + | . | . | + | + | 4 | II | 40 |
| Euri-Medit.-Turan. | T scap | Dasypirum villosum | . | . | . | . | . | 1 | + | . | . | + | 3 | II | 45 |
| Circumbor. | T scap | Atriplex patula | . | . | . | . | . | . | 2 | . | + | + | 3 | II | 170 |
| Subcosmop. | T scap | Chenopodium album | . | . | . | + | + | . | . | . | . | . | 2 | I | 20 |
| Eurasiat. | T scap | Sonchus oleraceus | + | . | . | . | . | . | . | . | . | + | 2 | I | 20 |
| Euri-Medit. | H bienn | Echium italicum | . | . | . | + | . | . | . | + | . | . | 2 | I | 20 |
| **Car. *Molinio-Arrhenatheretea*** | | | | | | | | | | | | | | | |
| Paleotemp. | H caesp | Dactylis glomerata | . | 2 | 1 | 1 | 2 | 2 | . | 2 | 2 | . | 7 | IV | 800 |
| Circumbor. | H ros | Taraxacum officinale | 1 | . | . | 1 | + | 2 | + | 1 | 1 | . | 7 | IV | 270 |
| Eurasiat. | H ros | Plantago lanceolata | 1 | 1 | . | 2 | + | 2 | . | . | . | . | 5 | III | 360 |
| Paleotemp. | H caesp | Arrhenatherum elatius | . | . | . | 2 | + | + | . | . | . | . | 3 | II | 170 |
| Paleotemp. | H ros | Potentilla reptans | 1 | . | . | . | . | + | . | . | . | . | 2 | I | 35 |
| Eurosiber. | H scap | Trifolium pratense | . | . | . | . | + | + | . | . | . | . | 2 | I | 20 |
| **Car. *Festuco-Brometea*** | | | | | | | | | | | | | | | |
| Eurasiat. | H scap | Galium verum | 1 | . | . | . | . | 1 | . | + | . | . | 3 | II | 60 |
| Medit.-Mont. | H scap | Calamintha nepeta | . | + | . | . | . | + | . | . | . | . | 2 | I | 20 |
| Euri-Medit. | T scap | Odontites lutea | . | . | + | . | + | . | . | . | . | . | 2 | I | 20 |
| **Altre specie** | | | | | | | | | | | | | | | |
| Eurasiat. | H scap | Medicago sativa | 1 | 1 | . | 1 | 1 | 1 | 2 | + | + | . | 8 | IV | 295 |
| Euri-Medit. | NP | Rubus ulmifolius | . | + | . | + | . | . | . | . | . | . | 2 | I | 20 |
| SE-Europ.-Caucas. | T scap | Cephalaria transsylvanica | . | . | r | . | + | . | . | . | . | . | 2 | I | 20 |
| Steno-Medit. | H scap | Reichardia picroides | . | 1 | . | . | . | . | . | . | + | . | 2 | I | 35 |
| Europ.-Caucas. | P lian | Clematis vitalba | . | . | . | . | + | . | . | . | 1 | . | 2 | I | 35 |
| Steno-Medit. | H bienn | Seseli tortuosum | . | . | . | . | . | + | . | . | + | . | 2 | I | 20 |

- *Galio albi - Plumbaginetum europaeae* ass. nova

| emento | Forma | N. del rilievo | 1 | 2 | 3 | 4 | 5 | 6 | 7* | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | | CLASS | Indice | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ologico | biologica | Altitudine (m) | 20 | 250 | 270 | 290 | 280 | 480 | 700 | 585 | 840 | 860 | 700 | 520 | 500 | 330 | 460 | 880 | 885 | 825 | 740 | 330 | PRE- | DI | di | PRE- |
| | | Esposizione | S | E | NE | NE | NE | - | W | SW | - | SE | W | E | E | - | NE | SSE | SE | E | W | ENE | SEN- | PRE- | ricopr. | SEN- |
| | | Inclinazione (°) | 30 | 30 | 30 | 15 | 40 | - | 15 | 10 | - | 20 | 20 | 30 | 30 | - | 25 | 20 | 15 | 25 | 30 | 30 | ZA | SEN- | specif. | ZA |
| | | Copert. vegetaz. (%) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 90 | 100 | 100 | 100 | 100 | (A) | ZA | (A) | (B) |
| | | Superf. ril. (mq) | 8 | 12 | 6 | 5 | 5 | 5 | 5 | 6 | 6 | 6 | 6 | 12 | 6 | 6 | 8 | 5 | 6 | 6 | 15 | 8 | | (A) | | |
| **ff. di associazione** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| edit. | G rad | Plumbago europaea | 4 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 3 | 3 | 4 | 4 | 3 | 3 | 3 | 3 | 4 | 3 | 4 | 4 | 4 | IV | 5250 | 15 |
| | H scap | Galium album | . | 2 | + | . | . | + | 2 | 2 | + | . | 1 | 1 | + | 1 | + | . | . | + | + | . | 2 | II | 320 | 11 |
| **ass. elytrigetosum athericae (A)** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | G rhiz | Elytrigia atherica | 2 | 1 | 3 | 3 | 2 | . | . | 2 | . | . | . | . | . | . | . | . | . | . | . | . | 5 | V | 2150 | 1 |
| lit. | T scap | Raphanus raphanistrum | + | + | + | . | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 4 | IV | 80 | - |
| it | T scap | Beta vulgaris | . | + | . | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 3 | III | 60 | - |
| | T scap | Sinapis alba | . | . | + | 1 | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 3 | III | 120 | - |
| edit | T scap | Sonchus tenerrimus | 2 | . | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 2 | III | 320 | - |
| **ass. elytrigetosum repentis (B)** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| r. | G rhiz | Elytrigia repens | . | . | . | . | 1 | . | 1 | . | 4 | 5 | . | 1 | 2 | . | . | 2 | 3 | 1 | 1 | . | 1 | I | 50 | 9 |
| it. | H scap | Eryngium campestre | . | . | . | . | . | + | . | . | . | + | . | . | + | . | + | + | + | + | . | + | - | | | 8 |
| | H scap | Galium verum | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | + | + | + | 1 | . | - | | | 5 |
| p. | H scap | Hypericum perforatum | . | . | . | . | . | . | + | . | . | . | . | . | . | . | + | + | . | + | . | . | - | | | 4 |
| . | H scap | Achillea collina | . | . | . | . | . | . | 1 | + | . | . | . | . | . | + | . | . | . | + | . | . | - | | | 4 |
| edit. | H scand | Convolvulus elegantissimus | . | . | . | . | . | + | . | . | . | . | . | . | . | . | + | . | . | . | . | . | - | | | 2 |
| **o viscosae-Agropyrion repentis / stalia repentis** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| p. | G rhiz | Convolvulus arvensis | 1 | . | + | + | + | + | . | + | + | 1 | . | + | + | . | . | . | + | 1 | + | + | 4 | IV | 110 | 10 |
| p. | H blenn | Daucus carota | . | 1 | + | + | . | 2 | + | . | . | . | . | + | . | + | + | . | . | + | + | + | 3 | III | 90 | 8 |
| op. | H scap | Rumex crispus | . | . | . | . | + | . | + | . | + | + | + | . | . | . | + | . | + | + | + | 1 | 1 | I | 20 | 9 |
| | H bienn | Anthemis tinctoria | . | 1 | . | . | . | . | + | . | . | 1 | . | + | 1 | . | . | + | . | . | . | . | 1 | I | 50 | 5 |
| -Subatl. | H scap | Diplotaxis tenuifolia | . | . | . | . | + | . | 1 | . | + | . | . | . | . | . | + | . | + | . | . | + | 1 | I | 20 | 5 |
| ca | H scap | Chondrilla juncea | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | . | . | + | + | - | | | 4 |
| r. | H rept | Agrostis stolonifera | . | . | . | . | . | . | . | . | . | . | . | . | . | 2 | . | . | . | . | + | . | - | | | 2 |
| r. | G rhiz | Equisetum ramosissimum | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | I | 50 | - |
| | H scap | Poa trivialis | . | . | . | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . | . | . | . | - | | | 1 |
| (nat.) | Ch suffr | Senecio inaequidens | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | - | | | 1 |
| **misietea vulgaris** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | H scap | Picris hieracioides | 1 | 1 | . | . | + | . | 1 | 1 | . | . | + | 1 | 1 | + | . | + | . | + | . | + | 3 | III | 120 | 9 |
| r. | H scap | Artemisia vulgaris | . | . | . | . | . | 2 | 2 | . | . | . | . | 2 | . | 1 | . | . | . | . | . | + | - | | | 5 |
| | H scap | Foeniculum vulgare | + | + | . | 1 | . | 1 | . | . | . | . | . | + | . | . | . | . | . | . | . | + | 3 | III | 90 | 3 |
| op. | H scap | Urtica dioica | . | . | . | . | . | . | + | . | . | . | 3 | . | . | 1 | . | . | . | . | + | . | - | | | 4 |
| | H scap | Linaria vulgaris | . | . | . | . | . | . | + | . | . | + | . | . | + | . | . | . | . | . | . | . | - | | | 3 |
| t. | G rhiz | Sambucus ebulus | + | . | . | . | . | . | . | . | . | . | . | + | . | + | . | . | . | . | . | . | 1 | I | 20 | 2 |
| l. | H scap | Cichorium intybus | + | + | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | 2 | II | 40 | 1 |
| | T scap | Galium aparine | . | . | . | . | . | . | . | . | . | + | . | + | + | . | . | . | . | . | . | . | - | | | 3 |
| op. | Ch suffr | Artemisia absinthium | . | . | . | . | . | 2 | . | . | . | . | 1 | . | . | . | . | . | . | . | . | . | - | | | 2 |
| dit. | H bienn | Onopordon illyricum | . | . | . | + | . | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | 1 | I | 20 | 1 |

| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| aleotemp. | H scap | Silene vulgaris | . | + | . | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | I | 20 | 1 |
| urasiat. | G rad | Cirsium arvense | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | 1 | | 20 | 1 |
| uri-Medit. | H scap | Ballota nigra | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | - | | | 1 |
| iat.) | H scap | Artemisia verlotorum | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | I | 20 | - |
| aleotemp. | H bienn | Cirsium vulgare | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | I | 20 | - |
| E-Asiat. | H bienn | Isatis tinctoria | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | . | . | . | . | . | - | | | 1 |
| urasiat. | H scap | Cruciata laevipes | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | - | | | 1 |
| E-Medit. | Ch frut | Ballota rupestris | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 2 | . | . | . | - | | | 1 |
| **ar. Stellarietea mediae** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| uri-Medit.-S-Sib. | T scap | Lactuca serriola | + | + | + | . | . | 2 | + | . | r | + | + | + | + | . | + | + | + | 1 | 1 | + | 3 | III | 60 | 13 |
| uri-Medit. | T scap | Bromus diandrus | 2 | 2 | . | . | 1 | 2 | 2 | . | 1 | . | 1 | 2 | 2 | . | 2 | 2 | 1 | 2 | 2 | 2 | 3 | III | 650 | 12 |
| uri-Medit. | T scap | Avena barbata | . | + | 1 | 1 | 1 | . | + | . | . | . | . | . | . | . | + | + | 1 | + | 1 | + | 4 | IV | 170 | 7 |
| uri-Medit.-Turan. | T scap | Dasypirum villosum | . | . | . | 1 | 1 | . | . | . | . | . | . | 2 | 1 | 2 | . | . | . | 2 | . | 1 | 2 | II | 100 | 5 |
| ircumbor. | T scap | Fallopia convolvulus | . | . | . | . | . | . | . | . | . | . | + | . | . | . | + | + | 1 | . | 1 | + | - | | | 6 |
| ircumbor. | T scap | Atriplex patula | . | . | . | . | . | . | + | . | . | r | + | + | . | + | . | . | . | . | . | . | - | | | 5 |
| ubcosmop. | T scap | Chenopodium album | . | . | . | . | . | + | + | . | . | . | . | . | . | + | . | + | + | . | . | . | - | | | 5 |
| edit.-Turan | H bienn | Carduus pycnocephalus | . | . | . | . | . | . | . | . | + | + | . | + | . | . | . | . | . | . | r | . | - | | | 4 |
| urosib. | T scap | Malva sylvestris | . | . | . | . | . | . | + | . | . | . | . | 1 | + | . | . | . | . | . | . | . | - | | | 3 |
| urop. | H bienn | Echium vulgare | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | . | + | . | . | . | - | | | 3 |
| urasiat. | T scap | Sonchus oleraceus | . | + | + | . | . | + | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 2 | II | 40 | 1 |
| -Medit. | T scap | Papaver rhoeas | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | + | . | + | - | | | 3 |
| aleotemp. | T scap | Mercurialis annua | . | . | . | . | . | . | . | . | . | . | . | + | . | 1 | . | . | . | . | . | . | - | | | 2 |
| **ar. Molinio-Arrhenatheretea** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| aleotemp. | H caesp | Dactylis glomerata | 1 | 2 | 1 | 1 | 1 | 2 | 1 | + | . | + | + | 2 | 2 | 2 | 2 | 1 | 1 | . | 1 | 2 | 5 | V | 500 | 13 |
| urasiat. | H ros | Plantago lanceolata | + | . | . | . | . | + | + | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | I | 20 | 2 |
| ircumbor. | H ros | Taraxacum officinale | . | . | . | . | . | + | . | . | . | . | . | . | . | + | + | . | . | . | . | . | - | | | 3 |
| aleotemp. | H ros | Potentilla reptans | . | . | + | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | . | 1 | I | 20 | 1 |
| **ar. Festuco-Brometea** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| edit.-Mont. | H scap | Calamintha nepeta | . | . | . | 1 | . | 1 | + | . | . | . | . | + | + | 1 | 1 | . | . | . | + | 1 | 1 | I | 50 | 8 |
| ubatl. | H caesp | Brachypodium rupestre | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | . | 1 | I | 50 | 1 |
| ndem. | G rhiz | Phleum ambiguum | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 2 | . | . | . | . | 1 | - | | | 2 |
| **ltre specie** | | | | | | | | | | | | | | | | | | | | | | | | | | |
| uri-Medit. | NP | Rubus ulmifolius | . | . | . | . | . | + | + | . | . | . | + | + | . | + | . | . | . | . | + | . | - | | | 6 |
| E-Eur.-Caucas. | T scap | Cephalaria transsylvanica | . | . | + | + | . | . | . | . | . | + | . | . | + | . | . | . | . | . | . | + | 2 | II | 40 | 3 |
| ur.-Caucas. | P lian | Clematis vitalba | . | . | . | . | . | + | . | . | . | . | . | + | . | + | . | . | . | . | . | 1 | - | | | 4 |
| leno-Medit. | H bienn | Seseli tortuosum | . | . | . | . | . | . | + | . | . | + | . | . | . | . | + | . | . | . | . | 1 | - | | | 4 |
| edit.-Atl. | H scap | Salvia verbenaca | . | . | . | . | . | + | + | . | . | . | . | 1 | . | . | . | . | + | . | . | . | - | | | 4 |
| uri-Medit. | T scap | Tordlium maximum | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | + | + | + | - | | | 4 |
| eno-Medit. | H scap | Reichardia picroides | . | + | . | . | . | + | . | . | . | . | . | + | . | . | . | . | . | . | . | . | 1 | I | 20 | 2 |
| aleotemp. | P caesp | Crataegus monogyna | . | . | . | . | . | . | . | . | + | r | . | . | . | . | . | . | r | . | . | . | - | | | 3 |
| urasiat. | H scap | Medicago sativa | . | . | . | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | + | - | | | 2 |
| ur.-Caucas. | P caesp | Prunus spinosa | . | . | . | + | . | . | . | . | . | . | . | . | + | . | . | . | . | . | . | . | 1 | I | 20 | 1 |
| osmop. | G rhiz | Cynodon dactylon | . | 1 | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | 1 | . | 1 | I | 50 | 1 |
| aleotemp. | NP | Rosa canina | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | . | . | + | . | - | | | 2 |
| ubcosmop. | H scap | Agrimonia eupatoria | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | + | + | - | | | 2 |
| eno-Medit. | H scap | Phlomis herba-venti | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | . | r | + | - | | | 2 |

La comunità con cui l'*Artemisio-Senecionetum* sembra mostrare le maggiori somiglianze è il *Dauco-Picridetum hieracioidis* Goers 1966, dell'Europa centrale. La proposta di formalizzare le differenze a livello di associazione vuole sottolineare l'autonomia delle cenosi abruzzesi sia floristica, evidenziata in particolare dalla presenza e/o consistenza delle specie caratteristiche e diferenziali, che ecologica, rimarcata anche dall'elevata espressività fisionomica della vegetazione, mantenuta e favorita nel tempo soprattutto dalle pratiche periodiche di sfalcio.

***Galio albi-Plumbaginetum europaeae*** ass. nova

Lungo le scarpate laterali delle strade la fisionomia della vegetazione è data da *Elytrigia repens* (= *Agropyron repens*), *Elytrigia atherica* (= *Agropyron pungens* auct. ital.) e *Plumbago europaea*. Quet'ultima è una geofita radicigemmata a distribuzione steno-mediterranea, che forma, negli ambienti studiati, popolamenti più o meno densi, a fenantesi autunnale.

Questo secondo tipo di vegetazione viene assegnato, sulla base dei rilievi di Tab. 2, ad una nuova associazione denominata *Galio albi-Plumbaginetum europaeae* (rilievo tipo n. 7 di Tab. 2), di cui sono specie caratteristiche e differenziali *Plumbago europaea* e *Galium album*.

L'associazione si inquadra nell'alleanza *Inulo viscosae-Agropyrion repentis*, istituita da Biondi e Allegrezza (1996) come variante submediterraneo-appenninica del *Convolvulo-Agropyrion repentis* a carattere temperato. L'alleanza afferisce all'ordine *Agropyretalia repentis* (classe *Artemisietea vulgaris*).

La minore igrofilìa rispetto all'*Artemisio-Senecionetum*, sottolineata da un minor numero e frequenza di specie della classe *Molinio-Arrhenatheretea*, deriva dalla maggiore distanza rispetto alla strada e dalla acclività delle stazioni che assicura un più pronunciato drenaggio.

Nutrito è, anche in questo caso, il corteggio delle specie della classe *Stellarietea mediae* e dell'ordine *Brometalia rubenti-tectori*; la presenza, anche consistente, di *Bromus diandrus*, evidenzia il contatto con cenosi afferenti all'ordine citato e, in particolare, con l'associazione *Aveno barbatae-Brometum diandri* o simili.

In Tab. 2 sono stati evidenziati due aspetti, che vengono interpretati come subassociazioni:

subass. *elytrigetosum athericae* (rill. 1-5), di cui sono specie differenziali *Elytrigia atherica, Raphanus raphanistrum, Beta vulgaris, Sinapis alba* e *Sonchus tenerrimus* (rilievo tipo n. 2 di Tab. 2); è l'aspetto più termofilo, relativo ai territori costieri e basso-collinari;

subass. *elytrigetosum repentis* (rill. 6-20), differenziata da *Elytrigia repens, Eryngiun campestre, Hypericum perforatum, Galium verum, Achillea collina* e *Convolvulus elegantissimus* (rilievo tipo n. 7 di Tab. 2); rappresenta le cenosi della fascia alto-collinare e montana.

**Considerazioni sugli spettri biologici e corologici**

Nello spettro biologico ponderato dell'*Artemisio absinthii-Senecionetum inaequidentis* dominano le camefite (46,5%) e le emicriptofite (39,8%); anche le terofite sono relativamente ben rappresentate (10,1%), mentre sono molto bassi i valori di geofite (3,1%) e fanerofite (0,5%).

Lo spettro biologico ponderato del *Galio albi-Plumbaginetum europaeae* mostra invece una netta dominanza delle geofite (70,9% nella subass. *elytrigetosum athericae* e 57,2% nella subass. *elytrigetosum repentis*), seguite dalle emicriptofite (13,8 e 23,8%). Il livello delle terofite (15,1 e 16,1%) è superiore all'associazione precedente, mentre scarsa è la presenza di camefite (0 e 1,9%) e fanerofite (0,2 e 1,0).

Lo spettro corologico ponderato dell'*Artemisio-Senecionetum* è dominato da specie ad ampia distribuzione (cosmopolite, subcosmopolite, avventizie) che assommano al 52,6%, seguite dalle eurasiatiche s.l. (22,7%) e dalle boreali (14,6%). Le mediterranee s.l. sono presenti con il 6,5% e le atlantiche s.l. con il 3,6%.

Nello spettro corologico del *Galio-Plumbaginetum* la percentuale più alta è raggiunta dalle specie mediterranee s.l. (83,3% nella subass. *elytrigetosum athericae* e 54,5% nella subass. *elytrigetosum repentis*). Seguono, a distanza, le eurasiatiche s.l. (11,9 e 16,2%), le boreali (2,0 e 19,1%) e quelle ad ampia distribuzione (2,1 e 8,3%). Trascurabili sono i valori delle atlantiche s.l. (0,7 e 0,9%) e delle endemiche (0 e 1,0%).

Dai dati esposti si deduce che l'*Artemisio-Senecionetum* possiede un carattere marcatamente nitrofilo-ruderale e decisamente continentale, denunciato dalle elevate presenze delle entità ad ampia distribuzione ed eurasiatiche s.l. Tale ecologia deriva dalla posizione di questa vegetazione a diretto contatto con la strada e dall' assenza di acclività delle stazioni.

Nel *Galio-Plumbaginetum* è invece evidente una marcata impronta mediterranea, che diventa molto decisa nella subassociazione *elytrigetosum athericae*. L'associazione mostra anche un non elevato livello di ruderalità e nitrofilÏa, evidenziato dai bassi

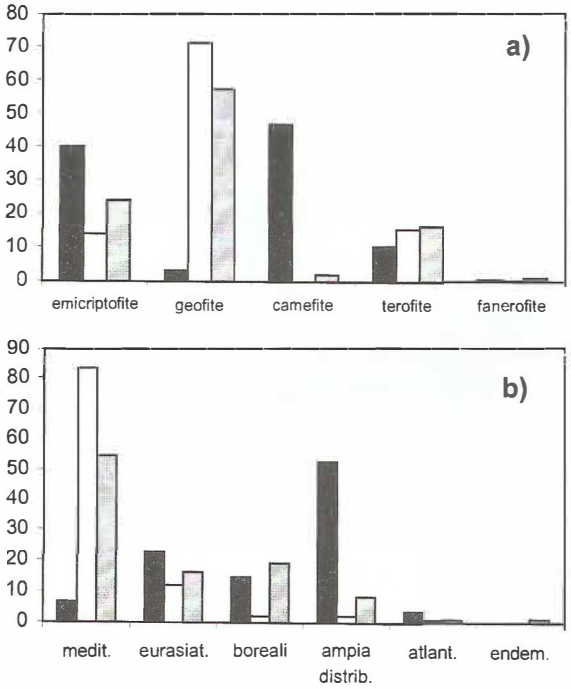


Fig. 2 - Spettri biologici (a) e corologici (b) dell'*Artemisio-Senecionetum* (■), *Galio-Plumbaginetum elytrigetosum athericae* (□) e *Galio-Plumbaginetum elytrigetosum repentis* (▒).

*Life form (a) and chorological (b) spectra of* Artemisio-Senecionetum (■), Galio-Plumbaginetum elytrigetosum athericae (□) *and* Galio-Plumbaginetum elytrigetosum repentis (▒).

valori delle entità ad ampia distribuzione. Tutto ciò dipende da vari fattori: maggiore distanza dal ciglio stradale, contatto con la vegetazione dei campi abbandonati, acclività delle stazioni.

## Appendice

Località, data e specie sporadiche dei rilievi:

Tabella 1 - Ril. 1: Tra Barisciano e Prata d'Ansidonia (AQ), 19.9.1995. Ril. 2: S. Atto di Teramo, 14.11.1997; *Sonchus asper* (+), *Conyza albida* (+). Ril. 3: Pressi di Monticchio (AQ), 19.9.1995; *Amaranthus retroflexus* (+), *Linaria purpurea* (+), *Eryngium campestre* (+). Ril. 4: Coppito (AQ), 9.10.1995; *Salvia verbenaca* (+), *Scabiosa columbaria* (1), *Galium album* (1), *Brachypodium rupestre* (+). Ril. 5: Pressi di Pettino (AQ), 28.9.1995; *Diplotaxis erucoides* (+), *Fallopia convolvulus* (+), *Trifolium repens* (+). Ril. 6: Pressi di Pettino (AQ), 28.9.1995; *Lolium perenne* (+), *Poa annua* (+). Ril. 7: Ofena (AQ), 2.10.1995; *Ecballium elaterium* (+), *Xanthium italicum* (1), *Silybum marianum* (+). Ril. 8: Caporciano (AQ), 25.9.1995. Ril. 9: Navelli (AQ), 25.9.1995; *Phleum ambiguum* (1). Ril. 10: L'Aquila, 19.9.1995; *Tordilium maximum* (+), *Lepidium graminifolium* (r), *Solanum nigrum* (+), *Mercurialis annua* (+), *Conyza canadensis* (+).

Tabella 2 - Ril. 1: Pescara, 14.10.1995; *Aster squamatus* (+), *Sorghum halepense* (+). Ril. 2: Alanno (PE), 1.10.1995; *Picris echioides* (+), *Consolida regalis* (+), *Brachypodium sylvaticum* (+), *Ulmus minor* (+). Rill. 3, 4: Alanno (PE), 1.10.1995. Ril. 5: Alanno (PE), 1.10.1995; *Oxalis articulata* (+). Ril. 6: Ofena (AQ), 2.10.1995; *Ailanthus altissima* (+), *Conyza canadensis* (+). Ril. 7: Tra Gioia dei Marsi e Venere (AQ), 8.10.1985. Ril. 8: Pressi di Monticchio (AQ), 19.9.1995; *Arrhenatherum elatius* (+). Rill. 9, 10: Tra Paganica e Barisciano (AQ), 19.9.1995. Ril. 11: Tra Navelli e Capestrano (AQ), 19.9.1995. Ril. 12: Trivento (CB), 24.9.1995; *Echium italicum* (+), *Eryngium amethystinum* (+). Ril. 13: Trivento (CB), 24.9.1995; *Erysimum cheiri* (+). Ril. 14: Bussi (PE), 18.9.1995; *Equisetum arvense* (1). Ril. 15: Capestrano (AQ), 18.9.1995; *Odontites lutea* (1). Ril. 16: Tra Poggio Picenze e Barisciano (AQ), 11.9.1995; Ril. 17: Tra Poggio Picenze e Barisciano (QA), 11.9.1995; *Orlaya grandiflora* (+). Ril. 18: S. Pio delle Camere (AQ), 11.9.1995. Ril. 19: Navelli (AQ), 11.9.1995; *Spartium junceum* (+). Ril. 20: Capestrano (AQ), 11.9.1995; *Sanguisorba minor* (+), *Scolymus hispanicus* (r).

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# CONTRIBUTIONS TO THE LICHEN FLORA OF CRETE: A COMPILATION OF REFERENCES AND SOME NEW RECORDS

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**Keywords:** biodiversity, checklist, Crete, flora, lichenicolous fungi, lichenized fungi, lichens, Mediterranean.

**Abstract:** An updated checklist of lichens of Crete is presented. A total of 440 taxa is reported. The checklist distinguishes 4 administrative subdivisions (prefectures) in Crete. Strong degradation of the vegetation throughout the island limits the abundance of corticolous lichens, only the woody patches in the western part contain a number of otherwise rare oceanic species.

## Introduction

The first lichen collections from Crete were reported by Zahlbruckner (1906). Some years later, Steiner (1916, 1919) published on collections made by Ginzberger and those gathered during an excursion of the University of Vienna. A larger number of specimens were collected by Rechinger during a longer stay on the island. These collections were determined and published by Szatala (1943a). These prior results were the basis for the first checklist by Kleinig (1966) who listed some 330 species, including 80 new records. Additional information was contributed by Rondon (1969), and is scattered throughout the literature. In this compilation we have tried to screen the literature completely, and also include data from various other collectors as well as some of our own collections.

## Survey area

Crete has a rather central location in the Mediterranean, and is, together with its surrounding small islets, the southernmost island complex of Europe. It is also the fifth-largest island in the Mediterranean with an area of 8729 square kilometers (after Sicily, Sardinia, Cyprus, and Corsica). The main island has a significant East-West orientation and measures 254 km in this direction, whereas its width is only 12 km at its narrowest and 56 km at its broadest point. The natural subdivision of the island is determined by its mountain systems, the Lefka Ori (2453 m), the Psiloritis (2456 m), which have snow cover mostly until June, and the lower systems, e.g. the Dikti mountains towards the east, and on the Sitia peninsula, the Orno ridges and the Afendis-Kavousi mountains (1476 m). Amidst the larger mountain systems, three highland plains (polje) are found: the Omalos, Lassithi, and Nida plains. The mountains ridges are steep at their southern ridges towards the Lybian sea, and interrupted by deep gorges, with Samaria as the most famous one. Several small islands surround Crete: Gramvoussa, Pontikinisi, Dia, Dyonisiades in the North, and Gavdos (i.e. the southernmost point of Europe), Paximadia, Chrisi, and Koufonisi in the South.

Crete is the remaining part of a larger geological folding system originating from the Oligocene, which connected the Peloponnes with the mountains of West Anatolia. This is part of the European plate, which is raised while the African plate moved underneath to the north beginning with the Cretaceous. A geological map was provided by Creutzberg *et al.* (1977). Phyllite-quartzites, with a richly developed lichen diversity, are the oldest metamorphic rocks on the island (at least 300 m years old) and mainly found in the western parts. A completely different lichen flora is found on platey limestones and crystalline limestones, which are otherwise dominating in the mountains and contributing to karst phenomena. The late tertiary to neogenic marl, sandstones and clays, are mainly found in the lowlands. Natural concretes, such as breccia and conglomerate, can be of any date, even less than 50 years old. The unstable structure of these sub-

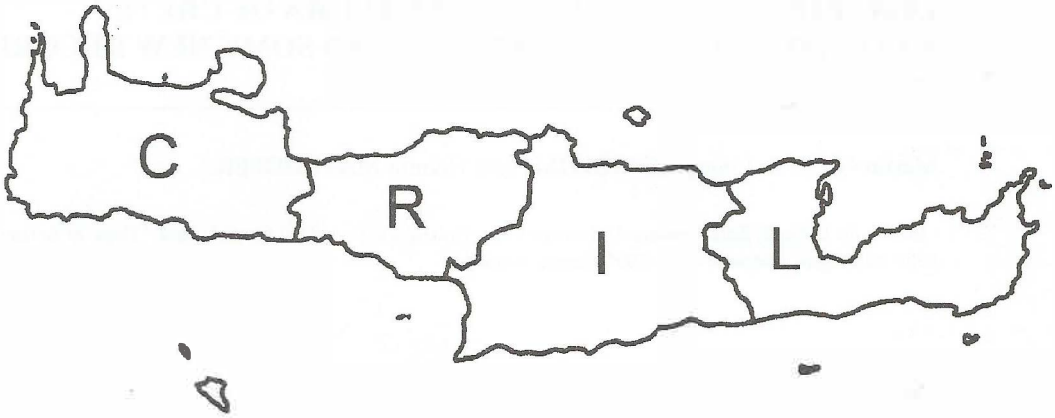


Fig. 1 - The island of Crete and its subdivision in prefectures: C = Nomos Chanion, R = Nomos Rethimnion, I = Nomos Irakliou, L = Nomos Lassithi.

strata does not support a well developed lichen flora.

Crete is characterized by a typical Mediterranean climate and influenced by different winds. In winter, the accompanying rains of the mainly westerly winds are the reason why Western Crete gets most of the precipitation, whereas the eastern and southern parts are more dry. A warm wind from the South, called Notia, which transports dust from Sahara, sometimes interferes in winter. In summer, relatively strong and cool winds from the North, the etesian winds, may occur. Frost is rare in the lowlands, whereas the mountains get snow down to 1600 m in winter, which is then persisting often until May. Rainfalls start in September to November, and reach their maximum in December and January. In June to August, even the mountains rarely get any rain. Fog is encountered mainly in northern exposed parts of the mountains. The often heavy rains, which are not absorbed by the soil, are of little use for the vegetation in general. However, in the valley systems in the West, they contribute to higher humidity.

The vegetation is mostly eumediterranean and, today, large closed forests are missing, contrasting with the descriptions of Homer and Theophrastus, who characterized Crete as an island with 'rich woodland'. However, it is difficult to estimate what exactly was understood under that term and, unfortunately, pollen deposits are rare. Rather dense chestnut-platane stands, often with oak are still found in the western, more humid part of the island. Large parts of the island, including the understorey of the woodlands are, however, influenced by grazing animals, and there is hardly any undisturbed locality. Open vegetation is mostly garigue (phrygana) or steppe, and well developed maquis is found only in the valleys of the western parts. Rondon (1969) provided some notes on common lichen habitats in Crete. To these we can add the observations that thorny cushion plants are an interesting microhabitat for lichens at higher altitudes, and that *Castanea* plantations in Western Crete are lichenologically interesting, especially in shaded gorges. Although the understorey and even branches of the trees in these plantations are heavily degraded by goat grazing, notable oceanic species, such as *Degelia plumbea* or various *Bacidia* species, are found here.

## Organization of the list

Four administrative subdivisions (prefectures, gr. Nomos) are distinguished (Fig. 1): C = Nomos Chanion, R = Nomos Rethimnion, I = Nomos Irakliou, L = Nomos Lassithi. R/I denotes the areas in the Psiloritis mountains where the corresponding prefecture can not be assigned. Details of new records for a prefecture are given in brackets after the abbreviation of the corresponding prefecture. As a literature reference we included the first publication of a specimen. Records of lichenicolous fungi include the name of their hosts.

## The list

***Acarospora cervina*** A. Massal.
Szatala 1943b; Kleinig 1966 – R (7 km S Anogia, 1993, leg. Nordin, UPS), I, L

***Acarospora glaucocarpa*** (Ach.) Körb.
Szatala 1943b – R
***Acarospora nodulosa*** (Dufour) Hue
Szatala 1943b – C
***Acarospora schleicheri*** (Ach.) A. Massal.
Rondon 1969 – C (Imbros, 1988, leg. Timdal, hb. Timdal)
***Acarospora smaragdula*** (Wahlenb.) A. Massal.
Zahlbruckner 1906 – I
***Acarospora sulphurata*** (Arnold) Arnold
Kleinig 1966 – R
***Acarospora umbilicata*** Bagl.
Syn. *Acarospora cretica* J. Steiner, *A. percaenoides* (Nyl.) Jatta
Zahlbruckner 1906; Steiner 1916 – I
***Acarospora veronensis*** A. Massal.
Szatala 1943b – C, R/I
***Acrocordia gemmata*** (Ach.) A. Massal.
R (Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS)
***Amandinea punctata*** (Hoffm.) Coppins & Scheid.
Syn. *Buellia myriocarpa* DC. (Mudd) var. *virens* J. Steiner; *Buellia aequata* (Ach.) Szatala
Steiner 1916 – I
***Anaptychia ciliaris*** (L.) Körb.
Szatala 1943b (var. *crinalis* (Schleich.) Rabenh., var. *melanosticta* (Ach.) Boist.); Kleinig 1966; Czeczuga *et al.* 1994 – C, R (Oros Idi, Skinakas, 1997, leg. Suppan, GZU), R/I
***Anema prodigulum*** (Nyl.) Henssen
Rondon 1969
***Arthonia dispersa*** (Schrad.) Nyl.
Szatala 1943b – I (Matala, 1997, leg. Grube, GZU), L
***Arthonia epiphyscia*** Nyl.
L (1,5 km S Kalavros, 1999, leg. Grube, GZU)
Host: *Physcia scopulorum*
***Arthonia galactites*** (DC.) Dufour
Zahlbruckner 1906 – I
***Arthonia meridionalis*** Zahlbr.
Szatala 1943b – L
***Arthonia palmicola*** Ach.
Szatala 1943b – L
***Arthonia pinastri*** Anzi
Sundin 1999 – L
***Arthothelium ruanum*** (A. Massal.) Körb.
Syn. *A. dispersum* auct.
Kleinig 1966 – S

***Aspicilia caesiocinerea*** (Nyl. ex Malbr.) Arnold
Syn. *Aspicilia subdepressa* (Nyl.) Arnold
Steiner 1916; Kleinig 1966, – C, I
***Aspicilia calcarea*** (L.) Mudd
Zahlbruckner 1906 (var. *concreta* Schaer.); Szatala 1943b (f. *atomaria* (A. Massal.) Hazsl.); Kleinig 1966; Rondon 1969; Eigler 1969; Papp *et al.* 1999 – C, I, L
***Aspicilia cheresina*** (Müll. Arg.) Hue var. ***microspora*** (Arnold) Clauzade & Cl. Roux
Syn. *Aspicilia microspora* (Zahlbr.) Hue
Szatala 1943b; Rondon 1969 – I, L
***Aspicilia cinerea*** (L.) Körb.
Zahlbruckner 1906; Kleinig 1966; Rondon 1969 – C, I, L
***Aspicilia contorta*** (Hoffm.) Kremp. ssp. ***contorta***
Syn. *Aspicilia viridescens* (A. Massal.) Hue
Zahlbruckner 1906; Szatala 1943b – C, R/I, I, L
***Aspicilia contorta*** ssp. ***hoffmanniana*** S. Ekman & Fröberg
Syn. *Aspicilia hoffmannii* auct.
Rondon 1969 – I (2 km W Festos, 1993, leg. Nordin, UPS)
***Aspicilia coronata*** (A. Massal.) Anzi
Szatala 1943b – C, I
***Aspicilia cupreoglauca*** de Lesd.
Rondon 1969
***Aspicilia esculenta*** (Pall.) Flagey
Syn. *Aspicilia desertorum* (Kremp.) Mer.
Szatala 1943b – C
***Aspicilia farinosa*** (Flörke) Arnold
Zahlbruckner 1906; Szatala 1943b; Rondon 1969 – I, L
***Aspicilia grisea*** Arnold
Kleinig 1966 – C
***Aspicilia intermutans*** (Nyl.) Arnold
Zahlbruckner 1906; Rondon 1969 – I, L

***Bacidia bagliettoana*** (A. Massal. & De Not.) Jatta
Syn. *Bacidia muscorum* (Sw.) Mudd
Kleinig 1966 – C, R (7 km SE Garazo, 1993, leg. Nordin, UPS)
***Bacidia delicata*** (Larbal. ex Leight.) Coppins
R (7 km S Anogia, 1993, leg. Nordin, UPS)
***Bacidia rosella*** (Pers.) De Not.
R (6 km N Apostoli, 1993, leg. Nordin, UPS; Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS)
***Bacidia subincompta*** (Nyl.) Arnold
Syn. *Bacidia affinis* (Stizenb.) Vain.
Szatala 1943b – C
***Bacidina assulata*** (Körb.) S. Ekman
Syn. *Bacidia intermedia* (Hepp) Vain.
Szatala 1943b – C

***Bagliettoa limborioides*** A. Massal.
Syn. *Bagliettoa sphinctrina* auct.
Kleinig 1966 – L

***Bagliettoa parmigera*** (J. Steiner) Vezda & Poelt
Syn. *Verrucaria calciseda* DC.; *Verrucaria parmigera* J. Steiner
Zahlbruckner 1906; Steiner 1916 (var. *calcivora* A. Massal.); Rondon 1969 – I, L

***Buellia epigaea*** (Pers.) Tuck.
Trinkaus & Mayrhofer 2000 – L

***Buellia stellulata*** (Taylor) Mudd
Syn. *Buellia maritima* (A. Massal.) Bagl.; *Buellia subalbula* (Nyl.) Müll. Arg.
Steiner 1916; Szatala 1943b – C, I, L

***Buellia subdisciformis*** (Leight.) Vain.
Szatala 1943b; Rondon 1969 – L

***Buellia vilis*** Th. Fr.
Kleinig 1966 – L

***Buellia zoharyi*** Galun (nom. cons. prop.)
Trinkaus & Mayrhofer 2000 – C

***Caloplaca alnetorum*** Giralt, Nimis & Poelt
R (Skinakas, 1997, leg. Suppan, GZU)

***Caloplaca alociza*** (A. Massal.) Mig.
Syn. *Caloplaca agardhiana* (A. Massal.) Clauzade & Cl. Roux
Zahlbruckner 1906 (f. *minuta*, f. *albomarginata*); Szatala 1943b (as *Blastenia*, several forms); Rondon 1969; Wunder 1974- C, I, L

***Caloplaca aractina*** (Fr.) Häyren
*Caloplaca viridirufa* auct.
Kleinig 1966 – L

***Caloplaca arenaria*** (Pers.) Müll. Arg.
Syn. *Caloplaca lamprocheila* (DC.) Flagey, *Caloplaca craspedia* (Ach.) Szatala
Steiner 1916; Szatala 1943a; Rondon 1969 – I

***Caloplaca aurantia*** (Pers.) Hellb.
Syn. *Caloplaca callopisma* (Ach.) Th. Fr.
Zahlbruckner 1906; Steiner 1916 (f. *orientalis*); Kleinig 1966; Rondon 1969 – C (1 km S Imbros, leg. Mayrhofer & Ertl, GZU), I, L

***Caloplaca biatorina*** (A. Massal.) J. Steiner
Kleinig 1966 – I

***Caloplaca carphinea*** (Fr.) Jatta
Papp *et al.* 1999 – C

***Caloplaca cerina*** (Ehrh. ex Hedw.) Th. Fr.
Zahlbruckner 1906; Kleinig 1966; Rondon 1969 – C, R (Skinakas, 1997, leg. Suppan, GZU; 7 km S Anogia, 1993, leg. Nordin, UPS), R/I

***Caloplaca chalybaea*** (Fr.) Müll. Arg.
Zahlbruckner 1906; Rondon 1969; Wunder 1974 – I, L

***Caloplaca chrysodeta*** (Vain. ex Räsänen) Dombr.
C (Agia Irini, 1998, leg. Trinkaus & Grube, GZU)

***Caloplaca circumalbata*** (Delile) Wunder var. ***candida*** (Stizenb.) Wunder
Wunder 1974 – C, L

***Caloplaca citrina*** (Hoffm.) Th. Fr.
Syn. *Caloplaca phlogina* (Ach.) Flag
Steiner 1916 – I

***Caloplaca crenularia*** (With.) J.R. Laundon
Szatala 1943a, Kleinig 1966; Rondon 1969; Papp *et al.* 1999 – C, L

***Caloplaca cretensis*** (Zahlbr.) Wunder
Syn. *Blastenia cretensis* Zahlbr.
Zahlbruckner 1906; Wunder 1974 – I

***Caloplaca erythrocarpa*** (Pers.) Zwackh
Syn. *Caloplaca lallavei* (Clemente) Flagey
Zahlbruckner 1906 (as *C. arenaria* var. *lallavei*); Kleinig 1966; Rondon 1969 – C (Imbros, 1997, leg. Mayrhofer & Ertl, GZU; Agios Nektarios, 1993, leg. Nordin, UPS), L

***Caloplaca ferruginea*** (Huds.) Th. Fr.
Zahlbruckner 1906; Kleinig 1966 – L

***Caloplaca flavescens*** (Huds.) J.R. Laundon
C (1 km S Imbros, leg. Mayrhofer & Ertl, GZU)

***Caloplaca flavorubescens*** (Huds.) J.R. Laundon
Syn. *Caloplaca salicina* (Schrad.) Szatala; *Caloplaca aurantiaca* s. lat.
Zahlbruckner 1906 (*Caloplaca aurantiaca* var. *diffracta*); Kleinig 1966; Rondon 1969 – R (Skinakas, 1997, leg. Suppan, GZU; 6 km NW Apostoli, 1993, leg. Nordin, UPS); L

***Caloplaca flavovirescens*** (Wulfen) Dalla Torre & Sarnth.
Kleinig 1966 – I

***Caloplaca fuscoatroides*** J. Steiner
Kleinig 1966 – C, L (Karidi, 1976, leg. Mayrhofer, GZU)

***Caloplaca grimmiae*** (Nyl.) H. Olivier
I (SE Agia Pelagia, 1997, leg. Grube, GZU)
Host: *Candelariella vitellina*

***Caloplaca haematites*** (St.-Amans) Zwackh
Kleinig 1966; Rondon 1969 – C, R/I, L

***Caloplaca herbidella*** (Hue) H. Magn.
C (Omalos, 1998, leg. Trinkaus & Grube, GZU)

***Caloplaca inconnexa*** (Nyl.) Zahlbr.
Rondon 1969

***Caloplaca lactea*** (A. Massal.) Zahlbr.
Zahlbruckner 1906; Kleinig 1966; Rondon 1969; Triebel 1989 – L, I

***Caloplaca lithophila*** H. Magn.
Kleinig 1966; Rondon 1969 – C, R

***Caloplaca necator*** Poelt & Clauzade
Rondon 1969

***Caloplaca ochracea*** (Schaer.) Flagey
Syn. *Xanthocarpia ochracea* (Schaer.) A. Massal.
Kleinig 1966; Hafellner & Poelt 1979 – L

***Caloplaca pyracea*** (Ach.) Th. Fr.
Syn. *Caloplaca luteoalba* auct. p.p.
Kleinig 1966; Zahlbruckner 1906 (+ f. *pyrithroma* (Ach.) Zahlbr.); Rondon 1969; Czeczuga *et al.* 1994 – C, I, L

***Caloplaca rechingeri*** Servít
Kleinig 1966 – I

***Caloplaca rhinodinoides*** J. Steiner
Kleinig 1966 – L

***Caloplaca rubelliana*** (Ach.) Lojka
Kleinig 1966 – L

***Caloplaca saxicola*** (Hoffm.) Nordin
Syn. *Caloplaca murorum* (Ach.) Th. Fr.
Zahlbruckner 1906; Kleinig 1966 – L

***Caloplaca scotoplaca*** (Nyl.) H. Magn.
Syn. *Caloplaca caesiorufa* auct.
Steiner 1916 – I

***Caloplaca tenuata*** (Nyl.) Zahlbr.
Rondon 1969

***Caloplaca variabilis*** (Pers.) Müll. Arg.
Syn. *Caloplaca paepalostoma* (Anzi) Jatta
Steiner 1916 (f. *acrustacea* Arnold); Rondon 1969 (+ f. *acrustacea*, + var. *ocellulata* (Ach.) Boist.); Wunder 1974 – C, R (6 km Se Nea Kria Vrisi, 1997, leg. Mayrhofer & Ertl, GZU; 14 km W Spili, 1993, leg. Nordin, UPS), I, L (Psichron, 1976, leg. Mayrhofer, GZU)

***Caloplaca velana*** (A. Massal.) Du Rietz var. ***velana***
Syn. *Caloplaca placidia* (A. Massal.) J. Steiner, *Caloplaca dolomiticola* (Hue) Zahlbr.
Rondon 1969 – C (Imbros gorge, 1997, leg. Grube, GZU), R (6 km NW Apostoli, 1993, leg. Nordin, UPS), I (1,5 km N Kounari, 1993, leg. Nordin, UPS; 2 km W Festos, 1993, leg. Nordin, UPS)

***Caloplaca velana*** var. ***schaereri*** (Arnold) Clauzade & Cl. Roux
Syn. *Caloplaca schaereri* (Flörke) Zahlbr.
Rondon 1969

***Caloplaca vitellinula*** auct.
Kleinig 1966 – R

***Caloplaca xantholyta*** (Nyl.) Jatta
C (1 km S Imbros, 1997, leg. Mayrhofer & Ertl, GZU)

***Candelariella aurella*** (Hoffm.) Zahlbr.
Syn. *Caloplaca subsimilis* Th. Fr., *Candelariella subsimilis* (Th. Fr.) J. Steiner
Steiner 1916; Szatala 1943b; Kleinig 1966 – C, I, L

***Candelariella medians*** (Nyl.) A.L. Sm.
I (2km W Festos, 1993, leg. Nordin, UPS), L (5km S Vai, 1976, leg. Mayrhofer, GZU)

***Candelariella vitellina*** (Hoffm.) Müll. Arg.
Zahlbruckner 1906; Kleinig 1966; Rondon 1969; Czeczuga *et al.* 1994; Papp *et al.* 1999 – C, R (1km S Kouroutes, 1976, leg. Mayrhofer, GZU), I

***Candelariella xanthostigma*** (Ach.) Lettau
Szatala 1943b – C

***Catillaria chalybeia*** (Borr.) A. Massal. var. ***chalybeia***
Zahlbruckner 1906; Szatala 1943b; Kilias 1981; Bellemère 1994 – C, I, L

***Catillaria chalybeia*** var. ***choropoliza*** (Nyl.) H. Kilias
Kilias 1981 – R

***Catillaria detractula*** (Nyl.) H. Olivier
Syn. *Lecania detractula* (Nyl.) Arnold
Szatala 1943b, Triebel 1989 – I, L

***Catillaria lenticularis*** (Ach.) Th. Fr.
Szatala 1943b; Rondon 1969 – C, I, L

***Catillaria mediterranea*** Hafellner
C (Omalos, 1998, leg. Trinkaus & Grube, GZU)
Host: *Anaptychia ciliaris*

***Catillaria nigroclavata*** (Nyl.) Schuler
R (3 km ESE Vrises, 1993, leg. Nordin, UPS; 6 km NW Apostoli, 1993, leg. Nordin, UPS)

***Cercidospora lobothalliae*** Nav.-Ros. & Calatayud ined.
C (Omalos, 500m SW Lakki, 1976, leg. Mayrhofer, GZU)
Host: *Lobothallia radiosa*

***Cladonia cariosa*** (Ach.) Spreng.
Szatala 1943b – C

***Cladonia cervicornis*** (Ach.) Flot. subsp. ***verticillata*** (Hoffm.) Ahti
Papp *et al.* 1999 – C

***Cladonia convoluta*** (Lam.) Anders
Syn. *Cladonia foliacea* (Huds.) Willd. var. *convoluta* (Lam.) Vain.; *Cladonia endiviaefolia* (Dicks.) Fr.
Zahlbruckner 1906; Steiner 1916; Szatala 1943b; Räsänen 1944; Rondon 1969; Papp *et al.* 1999- C, I

***Cladonia firma*** (Nyl.) Nyl.
Syn. *Cladonia nylanderi* Coutinho
Kleinig 1966 – L

***Cladonia foliacea*** (Huds.) Willd.
Kleinig 1966 – C, R (6 km NW Apostoli, 1993, leg. Nordin, UPS), I, L

***Cladonia furcata*** (Huds.) Schrad. ssp. ***furcata***
Kleinig 1966 – L

***Cladonia furcata*** ssp. ***subrangiformis*** (Sandst.) Abbayes
Kleinig 1966 – L
***Cladonia pocillum*** (Ach.) Grognot
Steiner 1916; Szatala 1943b; Rondon 1969 – I, R (6 km NW Apostoli, 1993, leg. Nordin, UPS), L
***Cladonia pyxidata*** (L.) Hoffm.
Szatala 1943b; Kleinig 1966; Rondon 1969; Papp *et al.* 1999 – L
***Cladonia rangiformis*** Hoffm.
Szatala 1943b – L
***Clauzadea immersa*** (Weber) Hafellner & Bellem.
Syn. *Protoblastenia immersa* (Weber) J. Steiner, *Biatora immersa* (Weber) Hepp
Szatala 1943b; Kleinig 1966 – C, L
***Clauzadea metzleri*** (Körb.) Clauzade & Cl. Roux ex D. Hawksw.
I (2km W Festos, 1993, leg. Nordin, UPS)
***Clauzadea monticola*** (Schaer.) Hafellner & Bellem.
Syn. *Protoblastenia monticola* (Schaer.) J. Steiner, *Lecidea fuscorubens* (Nyl.) Nyl.
Zahlbruckner 1906; Steiner 1916 – I, L (5km S Vai, leg. Mayrhofer, 1976, GZU).
***Collema callopismum*** A. Massal.
Syn. *Leptogium callopismum* (A. Massal.) Harm.
Szatala 1943b – C
***Collema crispum*** (Huds.) Weber ex F.H. Wigg.
Syn. *Collema cheilum* Ach.; *Collema crispum* var. *metzleri* (Arnold) Degel.; *Collema subcheilum* Harm.
Steiner 1916 (C. metzleri); Szatala 1943b; Degelius 1954 – C, I
***Collema cristatum*** (L.) Weber ex F.H. Wigg. var. ***cristatum***
Syn. *Collema granuliferum* Nyl.
Szatala 1943b; Kleinig 1966; Papp *et al.* 1999 – C, I, L
***Collema cristatum*** var. ***marginale*** (Huds.) Degel.
Syn. *Collema multifidum* (Scop.) Rabenh.
Zahlbruckner 1906 (var. *marginale*); Szatala 1943b (var. *jacobaefolium*) – L
***Collema flaccidum*** (Ach.) Ach.
R (7 km S Anogia, 1993, leg. Nordin, UPS)
***Collema furfuraceum*** (Arnold) Du Rietz
Sazatala 1943b – C, R (7 km S Anogia, 1993, leg. Nordin, UPS; Arkadi Monastery, on *Quercus macrolepis*, 1976, leg. H.J.M. Bowen, E)
***Collema multipunctatum*** Degel.
R (2 km NW Akoumia, 1993, leg. Nordin, UPS; Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS)
***Collema nigrescens*** (Huds.) DC.
R (Arkadi Monastery, on *Quercus macrolepis*, 1976, leg. H.J.M. Bowen, E)
***Collema occultatum*** Bagl.
R (6 km NW Apostoli, 1993, leg. Nordin, UPS)
***Collema polycarpon*** Hoffm.
Syn. *Collema stygium* Schaer.
Szatala 1943b; Degelius 1954; Kleinig 1966- C, I, L
***Collema ryssoleum*** (Tuck.) A. Schneider
Kleinig 1966 – C, R (1km S Kouroutes, 1976, leg. Mayrhofer, GZU), I
***Collema subnigrescens*** Degel.
Kleinig 1966 – C; R (Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS)
*Collema tenax* (Sw.) Ach. em. Degel.
Syn. *Collema pulposum* (Bernh.) Ach.
Szatala 1943b – C, R (6 km NW Apostoli, 1993, leg. Nordin, UPS)
***Collema undulatum*** Laurer ex Flot.
Kleinig 1966 – I

***Degelia plumbea*** (Lightf.) P.M. Jørg. & P. James
Czeczuga *et al.* 1994 – C (1km E Vlatos, 1998, leg. Trinkaus & Grube, GZU), I
***Dermatocarpon luridum*** (With.) J.R. Laundon
Syn. *Dermatocarpon fluviatile* (Weber) Th. Fr.
Kleinig 1966 – C
***Dermatocarpon miniatum*** (L.) W. Mann
Zahlbruckner 1906 – C, I
***Dimelaena oreina*** (Ach.) Norman
Obermayer 1997 – R
***Diploicia canescens*** (Dicks.) A. Massal.
Szatala 1943b – C
***Diploschistes actinostomus*** (Ach.) Zahlbr.
Zahlbruckner 1906; Rondon 1969 (var. *farinosus* (Anzi) Zahlbr.) – I
***Diploschistes diacapsis*** (Ach.) Lumbsch
Syn. *Diploschistes albescens* Lettau, *Diploschistes albissimus* (Ach.) Dalla Torre & Sarnth.
Steiner 1916; Szatala 1943b; Kleinig 1966; Rondon 1969; Lumbsch 1989 – C, I, L
***Diploschistes gypsaceus*** (Ach.) Zahlbr.
Zahlbruckner 1906 – L
The old record of this species could also refer to *D. diacapsis.*
***Diploschistes muscorum*** (Scop.) R. Sant.
Papp *et al.* 1999 – C, L
***Diploschistes ocellatus*** (Vill.) Norman
Szatala 1943b; Rondon 1969; Lumbsch 1989 – C (1 km S Imbros, leg. Mayrhofer & Ertl, GZU, Agios Nektarios, 1993, leg. Nordin, UPS), I (Rogdia, 1965, leg. Degelius, UPS), L

***Diploschistes scruposus*** (Schreb.) Norman
Syn. *Diploschistes violarius* (Nyl.) Lettau
Zahlbruckner 1906; Kleinig 1966 – R (1km S Kouroutes, 1976, leg. Mayrhofer, GZU), I, L

***Diplotomma alboatrum*** (Hoffm.) Flot.
Syn. *Buellia alboatra* (Hoffm.) Th. Fr.; *Buellia subochracea* (Zahlbr.) Steiner, *Diplotomma subochraceum* (Zahlbr.) Szatala
Zahlbruckner 1906 (as *B. alboatra* var. *subochracea*); Szatala 1943b – C, I, L

***Diplotomma chlorophaeum*** (Hepp ex Leight.) Szatala
Syn. *Buellia chlorophaea* (Müll. Arg.) Lettau
Rondon 1969

***Diplotomma epipolium*** (Ach.) Arnold
Syn. *Buellia epipolia* (Ach.) Mong.
Zahlbruckner 1906; Szatala 1943b; Rondon 1969 – C, R (Somidos, 1997, leg. Grube, GZU), L

***Diplotomma nivale*** (Bagl. & Carestia) Hafellner
Syn. *Diplotomma margaritaceum* (Sommerf.) Szatala, *Buellia nivalis* (Bag. & Car.) Hertel ex Haf.
Szatala 1943b – I, L

***Diplotomma pharcidium*** (Ach.) M. Choisy
Syn. *Buellia pharcidia* (Ach.) Malme
R (7 km S Anogia, 1993, leg. A. Nordin, UPS)

***Diplotomma populorum*** A. Massal.
Syn. *Buellia alboatra* var. *populorum* (A. Massal.) H. Olivier
Rondon 1969

***Diplotomma venustum*** Körb.
Syn. *Buellia venusta* (Körb.) Lettau
Nordin 2000 (map of K- chemotype).

***Dirina cretacea*** (Zahlbr.) Tehler
Syn. *Chiodecton cretaceum* Zahlbr.
Zahlbruckner 1906; Szatala 1943b; Rondon 1969; Tehler 1983; Roux 1991 (map) – R (Damioni, 13 km SW Spili, 1993, leg. Nordin, UPS), I, L

***Dirina massiliensis*** Durieu et Mont. f. ***massiliensis***
Syn. *Dirina repanda* Fr.
Szatala 1943b; Kleinig 1966; Rondon 1969; Tehler 1983; Roux 1991 (map). – C, R (6 km W Spili, 1993, Nordin, UPS), I, L

***Dirina massiliensis*** f. ***sorediata*** (Müll. Arg.) Tehler
Tehler 1983 – C (Agios Nektarios, 1993, leg. Nordin, UPS)

***Endocarpon pusillum*** Hedw.
R (7 km S Anogia, 1993, leg. Nordin, UPS)

***Evernia prunastri*** (L.) Ach.
Zahlbruckner 1906; Szatala 1943b; Kleinig 1966 – C, R, R/I

***Farnoldia jurana*** (Schaer.) Hertel
Syn. *Lecidea jurana* Schaer.
Kleinig 1966 – I

***Fulgensia bracteata*** (Hoffm.) Räsänen
Zahlbruckner 1906 – L

***Fulgensia fulgens*** (Sw.) Elenkin
Zahlbruckner 1906 – I

***Fulgensia fulgida*** (Nyl.) Szatala
Syn. *Caloplaca fulgida* (Nyl.) J. Steiner
Kleinig 1966; Westberg & Kärnefelt 1998 – C, L

***Fulgensia schistidii*** (Anzi) Poelt
Syn. *Caloplaca schistidii* (Anzi) Zahlbr.
Kleinig 1966 – C, R

***Fulgensia subbracteata*** (Nyl.) Poelt
Rondon 1969; Poelt 1965; Papp *et al.* 1999 – C, I, L

***Fuscopannaria ignobilis*** (Anzi) P.M. Jørg.
Syn. *Pannaria ignobilis* Anzi
Vezda 1995 – I

***Fuscopannaria leucophaea*** (Vahl) P.M. Jørg.
Syn. *Pannaria leucophaea* (Vahl) P.M. Jørg.
C (Omalos, 1998, leg. Trinkaus & Grube, GZU)

***Fuscopannaria leucosticta*** (Tuck.) P.M. Jørg.
Syn. *Pannaria leucosticta* (Tuck.) Nyl.
Zahlbruckner 1906; Szatala 1943b – C, R

***Fuscopannaria mediterranea*** (Tav.) P.M. Jørg.
Syn. *Pannaria mediterranea* Tav.
Jørgensen 1978 (map)

***Fuscopannaria olivacea*** (P.M. Jørg.) P.M. Jørg.
Syn. *Pannaria olivacea* P.M. Jørg.
Jørgensen 1978 (map); Vezda 1985 – C, R (7 km S Anogia, 1993, leg. Nordin, UPS; Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS)

***Gonohymenia nummularia*** (Nyl.) Henssen
C (Agios Nektarios, 1993, leg. Nordin, UPS)

***Gyalecta derivata*** (Nyl.) H. Olivier
R (Arkadi Monastery, on *Quercus macrolepis*, 1976, leg. H.J.M. Bowen, E)

***Gyalecta truncigena*** (Ach.) Hepp
C (1 km E Vlatos, 1998, leg. Trinkaus & Grube, GZU), R (Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS)

***Haematomma nemetzii*** J. Steiner
C – (*Temenia*, leg. Mayrhofer, 1999, GZU)

***Heppia lobatoplicata*** (de Lesd.) Timdal ined.
C (Imbros, leg. Timdal, 1988, O), R (Preveli, leg. Timdal, 1988, O), L (Lasíthi, leg. Timdal, 1995, O)

***Hymenelia epulotica*** (Ach.) Lutzoni
Syn. *Ionaspis epulotica* (Ach.) Arnold
Szatala 1943b; Kleinig 1966 – I, L

***Immersaria cupreoatra*** (Nyl.) Calatayud & Rambold
Syn. *Aspicilia cupreoatra* (Nyl.) Arnold; *Aspicilia olivacea* Bagl. & Carestia; *Bellemerea cupreoatra* (Nyl.) Clauzade & Cl. Roux
Zahlbruckner 1906 – R/I, I, L

***Lecania erysibe*** (Ach.) Mudd
Steiner 1916; Szatala 1943b; Kleinig 1966 – I, L

***Lecania rabenhorstii*** (Hepp) Arnold
I (2 km W Festos, 1993, leg. Nordin, UPS)

***Lecania spadicea*** (Flotow) Zahlbr.
Szatala 1943b; Rondon 1969; M. Mayrhofer 1988; Roux 1991 (map) – C, I, L

***Lecania subcaesia*** (Nyl.) de Lesd.
Szatala 1943b – C, I, L

***Lecania turicensis (Hepp) Müll. Arg.***
Syn. *Lecania albariella* (Nyl.) Müll. Arg.
Szatala 1943b; M. Mayrhofer, 1988 – C, L

***Lecanographa grumulosa*** (Dufour) Egea & Torrente
Syn. *Opegrapha grumulosa* Dufour; *Lecanactis dörfleri* Zahlbr.; *Lecanactis grumulosa* (Dufour) Fr.
Zahlbruckner 1906; Lettau 1937; Szatala 1943b; Torrente & Egea 1989 – I, L

***Lecanora agardhiana*** Ach.
Szatala 1943a (var. *pachnodes*); Szatala 1943b; Kleinig 1966 – I, L

***Lecanora albescens*** (Hoffm.) Branth. & Rostr.
Szatala 1943b – I, L

***Lecanora allophana*** Nyl.
Syn. *Lecanora subfusca* (L.) Ach., p.p.
Kleinig 1966; Rondon 1969 – I

***Lecanora argentata*** (Ach.) Malme
Syn. *Lecanora subfuscata* H. Magn.
Szatala 1943b; Kleinig 1966; Czeczuga *et al.* 1994 – C, R (Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS), I

***Lecanora bolcana*** (Pollini) Poelt
Rondon 1969 – R (1km S, Kouroutes, 1976, leg. H. Mayrhofer, GZU)

***Lecanora campestris*** (Schaer.) Hue
Kleinig 1966 – C (0,5 km SW Lakki, 1976, leg. Mayrhofer, GZU), R (1km S Kouroutes, 1976, leg. Mayrhofer, GZU), L

***Lecanora carpinea*** (L.) Vain.
Szatala 1943b – C

***Lecanora cenisia*** Ach.
Szatala 1943b – I

***Lecanora chlarotera*** Nyl.
Kleinig 1966; Rondon 1969 (+ f. *rugosella* (Zahlbr.) Poelt); Czeczuga *et al.* 1994 – C, R (Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS), I

***Lecanora dispersa*** (Pers.) Sommerf.
Zahlbruckner 1906 (as L. *crenulata* f. *dispersa*); Steiner 1916; Szatala 1943b; Rondon 1969; Grube & Hafellner 1990 – R/I, C, I

***Lecanora gangaleoides*** Nyl.
Szatala 1943b; Rondon 1969 – I, L (1km W Karidi, 1976, leg. Mayrhofer, GZU)

***Lecanora garovaglii*** (Körb.) Zahlbr.
Kleinig 1966 – I

***Lecanora graeca*** J. Steiner
Kleinig 1966 – I

***Lecanora hagenii*** (Ach.) Ach.
Steiner 1916 (var. *saxigena* J. Steiner); Szatala 1943b; Kleinig 1966; Rondon 1969 – C, I

***Lecanora horiza*** (Ach.) Linds.
Syn. *Lecanora sienae* de Lesd.
Rondon 1969 – C (1km S Omalos, 1976, leg. Mayrhofer, GZU)

***Lecanora intumescens*** (Rebent.) Rabenh.
Szatala 1943b (var. *glaucorufa* (Mart.) Körb.) – C

***Lecanora muralis*** (Schreb.) Rabenh.
Syn. *Squamaria muralis* (Schreb.) Elenkin; *Squamaria albomarginata* (Nyl.) Räsänen; *Lecanora albomarginata* Cromb.; incl. *Squamaria diffracta* (Ach.) Duby; *Squamaria versicolor* (Pers.) H. Olivier
Zahlbruckner 1906; Szatala 1943b; Kleinig 1966; Papp *et al.* 1999 – R, R/I, I, L

***Lecanora olivascens*** Nyl.
Kleinig 1966 – C

***Lecanora polytropa*** (Ehrh. ex Hoffm.) Rabenh.
Szatala 1943b – R/I

***Lecanora pruinosa*** Chaub.
Syn. *Lecanora (Placodium) sulphurella* (Körb.) H. Olivier; *Squamaria sulphurella* (Körb.) H. Olivier
Zahlbruckner 1906; Szatala 1943b; Rondon 1969 – C, R (14 km W Spili, 1993, leg. Nordin, UPS), I, L

***Lecanora pulicaris*** (Pers.) Ach.
Syn. *Lecanora chlarona* (Ach.) Nyl.; *Lecanora pinastri* (Schaer.) Choisy
Szatala 1943b; Kleinig 1966

***Lecanora reuteri*** Schaer.
Kleinig 1966 – I

***Lecanora rugosella*** Zahlbr.
Szatala 1943b – L

***Lecanora rupicola*** (L.) Zahlbr. ssp. ***rupicola***
Syn. *Lecanora glaucoma* (Hoffm.) Ach.
Zahlbruckner 1916; Szatala 1943b; Rondon 1969 – I

***Lecanora rupicola*** ssp. ***sulphurata*** (Ach.) Leuckert & Poelt
Syn. *Lecanora sulphurata* (Ach.) Nyl.
Zahlbruckner 1906; Szatala 1943b; Rondon 1969; Leuckert & Poelt 1989 – R/I, I, L

***Lecanora schistina*** (Nyl.) Arnold
Syn. *Lecanora praepostera* auct.
Szatala 1943b; Rondon 1969 – L

***Lecanora subrugosa*** Nyl.
Szatala 1943b – C

***Lecanora sulphurea*** (Hoffm.) Ach.
Zahlbruckner 1906; Szatala 1943b – I, L

***Lecanora umbrina*** (Ach.) A. Massal.
Szatala 1943b – L

***Lecanora varia*** (Hoffm.) Ach.
Kleinig 1966 – C

***Lecanora xanthostoma*** Wedd. ex Cl. Roux (nomen illegit.)
C (1 km S Imbros, leg. Mayrhofer & Ertl, GZU)

***Lecidea atrobrunnea*** (Ramaud ex Lam. & DC.) Schaer.
Zahlbruckner 1906; Kleinig 1966 – I

***Lecidea fuscoatra*** (L.) Ach.
Syn. *Lecidea grisella* Flörke
Rondon 1969- C (Street to Omalos, 500m SW Lakki, leg. Mayrhofer, 1976, GZU), I, L
This might also include the following references: Zahlbruckner 1906 (f. *mosigii* (Ach.) Nyl.); Szatala 1943b (f. *mosigii* (Ach.) Nyl., f. *subcontiguella* Vain., f. *cechumenoides* Vain.)

***Lecidea lapicida*** (Ach.) Ach. var. ***pantherina*** Ach.
Syn. *Lecidea subgrisella* Nyl.
Kleinig 1966 – I

***Lecidea promiscens*** Nyl.
Hertel 1971, 1995 – R
The species occurs on carbonate-free, siliceous rocks in alpine situations. The delimitation from *Lecidea auriculata* is sometimes problematic (Hertel 1995).

***Lecidea sarcogynoides*** Körb.
Szatala 1943b – C

***Lecidea xylophila*** Th. Fr.
Kleinig 1966 – C

***Lecidella anomaloides*** (A. Massal.) Hertel & H. Kilias
Syn. *Lecidea goniophila* auct.
Szatala 1943b – C, I

***Lecidella asema*** (Nyl.) Knoph & Hertel
Syn. *Lecidea subincongrua* Nyl.
Rondon 1969

***Lecidella atrosanguinea*** (Flörke) ined.
Zahlbruckner 1906 (as L. *enteroleuca* var. *atrosanguinea*) – L
See Santesson 1993 for the uncertain placement of this taxon.

***Lecidella carpathica*** Körb.
Syn. *Lecidea latypea* Ach.,
Zahlbruckner 1906; Szatala 1943b; Rondon 1969; Leuckert *et al.* 1990 – R (7 km S Anogia, 1993, leg. Nordin, UPS), R/I, I

***Lecidella elaeochroma*** (Ach.) M. Choisy
Syn. *Lecidea parasema* auct., *Lecidea olivacea* (Hoffm) A. Massal., ?*Lecidea epipolioides* var. *cacuminum* (J. Steiner) Szatala
Zahlbruckner 1906; Szatala 1943b; Kleinig 1966; Rondon 1969 – C, R/I, I, L

***Lecidella euphorea*** (Flörke) Hertel
Syn. *Lecidea euphorea* (Flörke) Nyl.
Szatala 1943b – C

***Lecidella patavina*** (A. Massal.) Knoph & Leuckert
Syn. *Lecidea endolithea* Lynge
Hertel 1967 – I

***Lecidella scabra*** (Taylor) Hertel & Leuckert
Syn. *Lecidea protrusa* Fr.
Szatala 1943b – L

***Lecidella stigmatea*** (Ach.) Hertel & Leuckert
Syn. *Lecidea stigmatea* Ach.
Szatala 1943b; Kleinig 1966; Hertel 1970b – C, I

***Lempholemma polyanthes*** (Bernh.) Malme
R (14 km W Spili, 1993, leg. Nordin, UPS)

***Lepraria nivalis*** J.R. Laundon
I (1,5 km N Kounari, 1993, leg. Nordin, UPS)

***Leprocaulon microscopicum*** (Vill.) Gams
C (3 km N Omalos, 1993, leg. Nordin, UPS)

***Leptogium biatorinum*** (Nyl.) Leight.
Syn. *Leptogium pusillum* Nyl.
Steiner 1916 – I

***Leptogium ferax*** (Durieu & Mont.) Rabenh.
Arvidsson 1984 – I

***Leptogium gelatinosum*** (With.) J.R. Laundon
Syn. *Leptogium sinuatum* (Huds) A. Massal.
Kleinig 1966 – C

***Leptogium lichenoides*** (L.) Zahlbr.
Szatala 1943b; Rondon 1969 (as var. *pulvinatum* (Hoffm.) Zahlbr.) – L, R (7 km S Anogia, 1993, leg. Nordin, UPS, 3 km ESE Vrises, 1993, leg. Nordin, UPS)

***Leptogium saturninum*** (Dicks.) Nyl.
R (7 km S Anogia, 1993, leg. Nordin, UPS)

***Leptogium schraderi*** (Bernh.) Nyl.
C (3 km N Omalos, 1993, leg. Nordin, UPS), I (2 km W Festos, 1993, leg. Nordin, UPS)

***Leptogium subtile*** (Schrad.) Torss.
R (Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS)

***Lethariella intricata*** (Moris) Krog
C (Gingilos, 1998, leg. J.W. Bjerke, hb. Bjerke)

***Lichenochora constrictella*** (Müll. Arg.) Hafellner
L (Mavros Kolimbos, 1997, leg. Grube, GZU)
Host: *Fulgensia* cf. *subbracteata.*

***Lichenostigma elongata*** Nav.-Ros. & Hafellner
Navarro-Rosinés & Hafellner 1996 – C
Host: *Lobothallia radiosa*

***Lindauopsis caloplacae*** Zahlbr.
Vouaux 1914
Host: *Caloplaca aurantia*

***Lithographa tesserata*** (DC.) Nyl.
Kleinig 1966 – L

***Lobothallia radiosa*** (Hoffm.) Hafellner
Syn. *Lecanora radiosa* (Hoffm.) Schaer., *Lecanora radiosa* var. *subcircinata* (Nyl.) Zahlbr., *Lecanora subcircinata* Nyl., *Squamarina subcircinata* (Nyl.) Kiffer
Zahlbruckner 1906; Szatala 1943b (as *Squamaria radiosa* (Hoffm.) Poetsch); Kleinig 1966; Rondon 1969; Navarro-Rosinés & Hafellner 1996; Papp *et al.* 1999 – C (1 km S Imbros, leg. Mayrhofer & Ertl, GZU), R/I, I, L

***Megaspora verrucosa*** (Ach.) Hafellner & V. Wirth
Syn. *Aspicilia mutabilis* (Ach.) Körb.; *Aspicilia verrucosa* (Ach.) Körb.
Szatala 1943b; Kleinig 1966 – C (Omalos, 1998, leg. Trinkaus & Grube, GZU; Xiloskalo, 1993, leg. Nordin, UPS), R (7 km S Anogia, 1993, leg. Nordin, UPS), I, L
The species is common on bark, however, the variety *mutabilis* is not distinguished as its value is unclear.

***Melanelia exasperata*** (De Not.) Essl.
Syn. *Parmelia aspidota* (Ach.) Poetsch
Szatala 1943b – C, R (7 km S Anogia, 1993, leg. Nordin, UPS), R/I

***Melanelia glabra*** (Schaer.) Essl.
Syn. *Parmelia glabra* Schaer.
Zahlbruckner 1906; Szatala 1943b – C, R (Skinakas, 1997, leg. Suppan, GZU; 7 km S Anogia, 1993, leg. Nordin, UPS), R/I

***Melanelia laciniatula*** (Flagey ex H. Olivier) Essl.
Syn. *Parmelia laciniatula* (Flagey ex Zahlbr.) Zahlbr.
Kleinig 1966 – C, R

***Micarea misella*** (Nyl.) Hedl.
R (7 km S Anogia, 1993, leg. Nordin, UPS)

***Muellerella lichenicola*** (Sommerf.: Fr.) D. Hawksw.
Triebel 1989 – I
Hosts: *Catillaria detractula, Caloplaca lactea*

***Muellerella pygmaea*** (Körb.) D. Hawksw. var. ***pygmaea***
Triebel 1989 – I
Host: *Acarospora* sp.

***Mycobilimbia hypnorum*** (Lib.) Kalb & Hafellner
Syn. *Lecidea fusca* (Schaer.) Th. Fr.
Szatala 1943b – L

***Mycobilimbia lurida*** (Ach.) Hafellner & Türk
Syn. *Lecidea lurida* Ach.
Szatala 1943b; Kleinig 1966; Papp *et al.* 1999 – C, I, L

***Myxobilimbia lobulata*** (Sommerf.) Hafellner
Syn. *Toninia syncomista* (Flörke) Th. Fr.
Szatala 1943b – R/I

***Naetrocymbe fraxini*** (A. Massal.) R.C. Harris
Syn. *Arthopyrenia fraxini* A. Massal.
R (Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS)

***Naetrocymbe punctiformis*** (Pers.) R.C. Harris
Syn. *Arthopyrenia punctiformis* (Pers.) A. Massal.
Rondon 1969

***Neofuscelia attica*** (Leuckert, Poelt & B. Schwartz) Essl.
Leuckert *et al.* 1975 – C (Street to Omalos, 500 m SW Lakki, 1976, leg. Mayrhofer, GZU), I

***Neofuscelia delisei*** (Duby) Essl.
Syn. *Parmelia delisei* (Duby) Nyl.
Szatala 1943b – R/I, I, L

***Neofuscelia glabrans*** (Nyl.) Essl.
Syn. *Parmelia pulla* Ach. ssp. *glabrans* (Nyl.) Clauzade & Cl. Roux, *Parmelia glabrans* Nyl.
Rondon 1969

***Neofuscelia loxodes*** (Nyl.) Essl.
Syn. *Parmelia isidiotyla* Nyl.
Szatala 1943b, Leuckert *et al.* 1975 – L

***Neofuscelia pokornyi*** (Körb.) Essl.
Syn. *Parmelia pokornyi* (Körb.) Szatala
Kleinig 1966 – C

***Neofuscelia pulla*** (Ach.) Essl.
Syn. *Parmelia prolixa* (Ach.) Carroll
Zahlbruckner 1906; Szatala 1943b; Kleinig 1966; Esslinger 1977 (map); Papp *et al.* 1999 – R (1 km S Kouroutes, 1976, leg. Mayhofer, GZU), I, L

***Nephroma laevigatum*** Ach.
Kleinig 1966 – C

***Normandina pulchella*** (Borrer) Nyl.
C (1km E Vlatos, 1998, leg. Trinkaus & Grube, GZU)

***Ochrolechia balcanica*** Verseghy
C (Omalos, 1976, leg. Mayrhofer, GZU)
***Ochrolechia pallescens*** (L.) A. Massal.
Szatala 1943b; Kleinig 1966 – R
***Ochrolechia parella*** (L.) A. Massal.
Zahlbruckner 1906; Szatala 1943b; Kleinig 1966; Rondon 1969; Verseghy 1962 (var. *kretaensis* Verseghy) – I, L
***Ochrolechia tartarea*** (L.) A. Massal.
Zahlbruckner 1906 – R, L
***Ochrolechia turneri*** (Sm. & Sowerby) Hasselrot
R (7 km S Anogia, 1993, leg. Nordin, UPS)
***Opegrapha calcarea*** Sm.
Syn. *Opegrapha chevallieri* Leight.
Zahlbruckner 1906; Szatala 1943b; Rondon 1969 – I, L
***Opegrapha durieui*** Mont.
Syn. *Enterographa durieui* (Mont.) Redgr.
Szatala 1943b; Roux 1991 (map) – L
***Opegrapha rupestris*** Pers.
Syn. *Opegrapha saxatilis* DC.; *Opegrapha saxicola* Ach.
Kleinig 1966 – I (1,5 km N Kounari, 1993, leg. Nordin, UPS), L
***Opegrapha varia*** Pers.
R (3km ESE Vrises, 1993, leg. Nordin, UPS)
***Opegrapha variaeformis*** Anzi
Kleinig 1966 – L

***Parmelia sulcata*** Taylor
Kleinig 1966 – C
***Parmelina carporrhizans*** (Taylor) Poelt & Vezda
R (Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS)
***Parmelina pastillifera*** (Harm.) Hale
C (Omalos, 1993, leg. Nordin, UPS), R (Skinakas, 1997, leg. Suppan, GZU; 7 km S Anogia, 1993, leg. Nordin, UPS)
***Parmelina tiliacea*** (Hoffm.) Hale
Syn. *Parmelia scortea* (Ach.) Ach.
Zahlbruckner 1906; Szatala 1943b; Kleinig 1966; Rondon 1969; Czeczuga *et al.* 1994 – R (Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS), I, S
***Peltigera canina*** (L.) Willd.
Kleinig 1966; Vitikainen 1994 (map). – C, R/I
***Peltigera collina*** (Ach.) Schrad.
Syn. *Peltigera scutata* (Dicks.) Duby
Kleinig 1966 – R/I
***Peltigera polydactyla*** (Neck.) Hoffm. s. lat.
Kleinig 1966 – C, I
***Peltigera praetextata*** (Flörke ex Sommerf.) Zopf
Vitikainen 1994 (map)
***Peltigera rufescens*** (Weiss) Humb.
R (7 km S Anogia, 1993, leg. Nordin, UPS)
***Pertusaria albescens*** (Huds.) M. Choisy & Werner
Syn. *Pertusaria discoidea* (Pers.) Malme, *P. globulifera* (Turner) A. Massal.
Szatala 1943b; Kleinig 1966 – C, I, L
***Pertusaria chiodectonoides*** Bagl. ex A. Massal.
Syn. *Pertusaria inquinata* (Ach.) Th. Fr.
Szatala 1943b – L
***Pertusaria dalmatica*** Erichsen
Szatala 1943b; Schmitz *et al.* 1994 – C
***Pertusaria flavicans*** Lamy
Szatala 1943b; Rondon 1969; Hanko 1983 – L
***Pertusaria hemisphaerica*** (Flörke) Erichsen
Szatala 1943b – C, I
***Pertusaria hymenea*** (Ach.) Schaer.
Syn. *Pertusaria lecanorodes* Erichsen, *Pertusaria wulfenii* DC.
Szatala 1943b; Kleinig 1966 – C, R (Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS), R/I, I
***Pertusaria leucostoma*** A. Massal.
Syn. *Pertusaria leioplaca* DC.
Szatala 1943b – L
***Pertusaria pentelisi*** J. Steiner
Syn. *Melanaria pentelisi* (J. Steiner) Erichsen ("*pentelici*")
Szatala 1943b; Rondon 1969 – I
***Pertusaria pertusa*** auct.
Szatala 1943b; Kleinig 1966; Hanko 1983 – C, R/I, I, L
***Pertusaria pluripuncta*** Nyl.
Syn. *Pertusaria gallica* De Lesd.
L (1 km W Karidi, 1976, leg. Mayrhofer, GZU)
***Pertusaria rupicola*** (Fr.) Harm.
Szatala 1943b; Rondon 1969; Leuckert *et al.* 1969; Hanko 1983 – I
***Petractis clausa*** (Hoffm.) Kremp.
Zahlbruckner 1906; Steiner 1916 (var. *eradiata* J. Steiner); Vězda 1965 – I, L
***Phaeophyscia hirsuta*** (Mereschk.) Essl.
R (Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS)
***Phaeophyscia orbicularis*** (Neck.) Moberg
C (Agios Nektarios, 1993, leg. Nordin, UPS), R (7 km S Anogia, 1993, leg. Nordin, UPS)
***Physcia adscendens*** (Fr.) H. Olivier
Kleinig 1966; Rondon 1969 – C, I, L

***Physcia aipolia*** (Ehrh. ex Humb.) Hampe
Kleinig 1966 – R (Skinakas, 1997, leg. Suppan, GZU), L

***Physcia albinea*** (Ach.) Nyl.
Szatala 1943b – L

***Physcia biziana*** (A. Massal.) Zahlbr.
Szatala 1943b; Kleinig 1966; Rondon 1969 – C, R (6 km Se Nea Kria Vrisi, 1997, leg. Mayrhofer & Ertl, GZU; 2 km NW Akoumia, 1993, leg. Nordin, UPS), L (W of Exo Lakonia, leg. Degel., UPS)

***Physcia caesia*** var. ***caesiella*** (de Lesd.) Clauzade & Cl. Roux
R (1km S Kouroutes, 1976, leg. Mayrhofer, GZU)

***Physcia leptalea*** (Ach.) DC.
Syn. *Physcia semipinnata* (J.F. Gmelin) Moberg
Zahlbruckner 1906 (*stellaris* var. *leptalea* Nyl.); Szatala 1943b; Kleinig 1966; Rondon 1969; Vezda 1995; Moberg 1994 – C, R (Skinakas, 1997, leg. Suppan, GZU; 6 km NW Apostoli, 1993, leg. Nordin, UPS)

***Physcia scopulorum*** (Lambinon & Vězda) Poelt & Nimis
L (1,5 km S Kalavros, 1999, leg. Grube, GZU; filed under *Arthonia epiphyscia*)

***Physcia stellaris*** (L.) Nyl.
Szatala 1943b (var. *rosulata* (Ach.) Hue); Kleinig 1966 – C, R/I

***Physcia wainioi*** Räsänen
Papp *et al.* 1999 – C

***Physconia detersa*** (Nyl.) Poelt
Kleinig 1966 – C

***Physconia distorta*** (With.) J.R. Laundon
C (Gingilos, 1998, leg. J.W. Bjerke, hb. Bjerke; Imbros gorge, 1998, leg. J.W. Bjerke, hb. Bjerke)

***Physconia grisea*** (Lam.) Poelt
Kleinig 1966 – C

***Physconia pulverulenta*** (Anzi) Jatta
Syn. *Physcia pulverulenta* (Schreb.) Nyl. f. *argyphaea* and var. *subvenusta*
Zahlbruckner 1906 – R/I, L

***Physconia servitii*** (Nádv.) Poelt
R (Adelaki, 12 km S Rethimno, 1993, leg. Nordin, UPS)

***Physconia subpulverulenta*** (Szatala) Poelt
Poelt 1966 – C

***Physconia venusta*** (Ach.) Poelt
Syn. *Physcia venusta* (Ach.) Nyl.
Szatala 1943b (+ var. *subvenusta* (Nyl.) Oliv.); Kleinig 1966 – C, R/I, R (7 km S Anogia, 1993, leg. Nordin, UPS)

***Placolecis opaca*** (Fr.) Hafellner
Syn. *Astroplaca opaca* (Fr.) Bagl.
Szatala 1943b – C

***Placidium lachneum*** (Ach.) Breuss
Syn. *Catapyrenium lachneum* (Ach.) R. Sant., *Dermatocarpon lachneum* (Ach.) A.L. Sm.
Kleinig 1966 – C, I, L

***Placidium lacinulatum*** (Ach.) Breuss
Syn. *Catapyrenium lacinulatum* (Ach.) Breuss
R (7 km SE Garazo, 1993, leg. Nordin, UPS)

***Placidium pilosellum*** (Breuss) Breuss
Syn. *Catapyrenium pilosellum* Breuss
Breuss 1990 – L

***Placidium squamulosum*** (Ach.) Breuss
Syn. *Dermatocarpon hepaticum* (Ach.) Th. Fr., *Catapyrenium squamulosum* (Ach.) Breuss
Szatala 1943b; Kleinig 1966; Breuss 1990 – C, I, L

***Placynthium nigrum*** (Huds.) Gray
Kleinig 1966 – C, I

***Platismatia glauca*** (L.) W.L. Culb. & C.F. Culb.
C (Gingilos, 1998, leg. J.W. Bjerke, herb. Bjerke)

***Pleopsidium flavum*** (Bellardi) Körb.
Syn. *Acarospora oxytona* (Ach.) A. Massal.
Kleinig 1966 – C, R/I

***Pleurosticta acetabulum*** (Neck.) Elix & Lumbsch
Syn. *Parmelia acetabulum* (Neck.) Duby
Zahlbruckner 1906; Szatala 1943b; Kleinig 1966 – C, R (Skinakas, 1997, leg. Suppan, GZU), R/I, R (7 km S Anogia, 1993, leg. Nordin, UPS), L

***Polyblastia terrestris*** Th. Fr.
C (Agios Nektarios, 1993, leg. A. Nordin, UPS)

***Polycoccum marmoratum*** (Kremp.) D. Hawksw.
Syn. *Microthelia marmorata* (Kremp.) Körb.
Szatala 1943b; Kleinig 1966 – C, R/I

***Polycoccum*** sp.
R (Agios Pavlos, leg. Grube, GZU)
Host: *Melanelia* sp.

***Polycoccum*** sp.
This species is distinct from any described species on *Physciaceae*, including the species mentioned by Matzer *et al.* (1997), which is probably identical to *Didymosphaeria echinospora* Faurel.
Host: *Rinodina obnascens*

***Polysporina simplex*** (Davies) Vězda
Syn. *Sarcogyne simplex* (Davies) Nyl.
Zahlbruckner 1906; Szatala 1943b; Rondon 1969 – C, L

***Porina linearis*** (Leight.) Zahlbr.
Kleinig 1966; Rondon 1969 – I

***Porpidia albocaerulescens*** (Wulfen) Hertel & Knoph
Syn. *Lecidea albocaerulescens* (Wulfen) Ach.
Zahlbruckner 1906 (+f. *alpina* Schaer.); Rondon 1969 – L

***Porpidia crustulata*** (Ach. ) Hertel & Knoph
Hertel 1992, Papp *et al.* 1999 – C, I

***Porpidia macrocarpa*** (DC.) Hertel & A.J. Schwab
Syn. *Lecidea macrocarpa* (DC.) Steud., *Lecidea contigua* auct.
Zahlbruckner 1906 (var. *platycarpa* (Ach.) Th. Fr.); Kleinig 1966 – C, I, L

***Protoblastenia calva*** (Dicks.) Zahlbr.
Kleinig 1966 – C, R, I, L

***Protoblastenia incrustans*** (DC.) J. Steiner
Kleinig 1966 – L

***Protoparmelia badia*** (Hoffm.) Hafellner
Syn. *Lecanora badia* (Hoffm.) Ach.
Kleinig 1966 – C, L

***Protoparmelia montagnei*** (Fr.) Poelt & Nimis
Syn. *Lecanora montagnei* (Fr.) Schaer.
Szatala 1943b – I, L (1km W Karidi, 1976, leg. Mayrhofer, GZU)

***Protoparmelia psarophana*** (Nyl.) Sancho & Crespo
Syn. *Lecanora psarophana* Nyl.
Szatala 1943b (var. *reagens* Servít.); Rondon 1969 (+ var. *reagens*) – L

***Pseudevernia furfuracea*** (L.) Zopf var. ***furfuracea***
Syn. *Parmelia furfuracea* (L.) Ach.
Kleinig 1966 – C

***Pseudevernia furfuracea*** (L.) Zopf var. ***ceratea*** (Ach.) D. Hawksw.
Syn. *Parmelia olivetorina* (Zopf) Zopf; *Parmelia furfuracea* var. *olivetorina*
Zahlbruckner 1906; Szatala 1943b – C, R

***Psora decipiens*** (Hedw.) Hoffm. var. ***decipiens***
Syn. *Lecidea decipiens* (Hedw.) Ach.
Zahlbruckner 1906; Steiner 1916; Szatala 1943b; Kleinig 1966; Rondon 1969; Schneider 1979, Papp *et al.* 1999 – C, R (Psilorítis, 1988, leg. Timdal, hb. Timdal), I, L

***Psora decipiens*** var. ***galactina*** Zahlbr.
Zahlbruckner 1906; Kleinig 1966; Schneider 1979; Timdal 1984 – C, I

***Psora gresinonis*** de Lesd.
Syn. *Lecidea gresinonis* (de Lesd.) Zahlbr.
Kleinig 1966; Timdal 1984 – L

***Psora pseudorussellii*** Timdal
C (2 km N of Omalos, 1988, leg. Timdal, hb. Timdal)

***Psora testacea*** (Hoffm.) Ach.
Syn. *Lecidea testacea* (Hoffm.) Ach.
Papp *et al.* 1999 – C (2 km N Omalos, 1988, leg Timdal, hb. Timdal), R (7 km Se Garazo, 1993, leg. Nordin, UPS), I (Iouhtas, 1995, leg. Rui & Timdal, hb. Timdal), L

***Psora vallesiaca*** (Schaer.) Timdal
Syn. *Lecidea deceptoria* Nyl.
Kleinig 1966 – C, L (between Tzermiádhes and Neápolis, 1995, leg Rui & Timdal, hb. Timdal)

***Psorotichia schaereri*** (A. Massal.) Arnold
Rondon 1969 – C (Agios Nektarios, 1993, leg. Nordin, UPS)

***Pyrenula chlorospila*** (Nyl.) Arnold
C (1km E Vlatos, 1998, leg. Trinkaus & Grube, GZU)

***Ramalina breviuscula*** Nyl.
L (1 km W of Karidi, 1976, H. Mayrhofer, GZU)

***Ramalina calicaris*** (L.) Fr.
? *Ramalina graeca* Müll. Arg.
Szatala 1943b; Kleinig 1966 – R/I

***Ramalina farinacea*** (L.) Ach.
Szatala 1943b (var. *gracilenta* Ach.); Kleinig 1966 – I

***Ramalina fastigiata*** (Pers.) Ach.
Kleinig 1966 – C, R/I, I

***Ramalina fraxinea*** (L.) Ach.
Kleinig 1966 – C (Omalos, 1976, leg. Mayrhofer, GZU), R, R/I

***Ramalina pollinaria*** (Westr.) Ach.
Rondon 1969

***Ramalina polymorpha*** (Lilj.) Ach.
Szatala 1943b (f. *emplecta* Ach.) – S

***Ramalina requienii*** (De Not.) Jatta
Szatala 1943b; Rondon 1969; Vezda 1969 – I, L

***Rhizocarpon distinctum*** Th. Fr.
Zahlbruckner 1906; Szatala 1943b; Feuerer 1991 – I, L

***Rhizocarpon geographicum*** (L.) DC. ssp. ***geographicum***
Zahlbruckner 1906 (f. *contiguum* Fw.); Szatala 1943b (f. *contiguum* Fw., f. *atrovirens* (L.) Massal.); Kleinig 1966; Rondon 1969 – C, R (7 km S Anogia, 1993, leg. Nordin, UPS), R/I, I, L

***Rhizocarpon geographicum*** ssp. ***kittilense*** (Räsänen) Sant. ad int.
Syn. *Rhizocarpon riparium* Räsänen
Szatala 1943b – R/I

***Rhizocarpon macrosporum*** Räsänen
Runemark 1956 – R/I

***Rhizocarpon polycarpum*** (Hepp) Th. Fr.
Szatala 1943b – I

***Rhizocarpon tinei*** (Tornab.) Runemark
Runemark 1956, Hertel 1983 – I

***Rhizocarpon viridiatrum*** (Wulfen) Körb.
Kleinig 1966 – L

***Rimularia insularis*** (Nyl.) Rambold & Hertel
Syn. *Lecidea intumescens* (Flörke) Nyl.
Szatala 1943b; Hertel 1970a (map); Hertel & Rambold 1990 – R/I, I

***Rinodina alba*** Metzler ex Arnold
Szatala 1943b (as *Rinodina atrocinerea* (Hook.) Körb.); Mayrhofer 1984 – L

***Rinodina bischoffii*** (Hepp) A. Massal.
Mayrhofer & Poelt 1979; Mayrhofer 1984 (map) – C (1 km S Imbros, leg. Mayrhofer & Ertl, GZU), L

***Rinodina calcarea*** (Arnold) Arnold
Poelt & Mayrhofer 1979; Mayrhofer & Poelt 1979; Mayrhofer 1984 (map) – L

***Rinodina confragosa*** (Ach.) Körb.
Szatala 1943b (+ var. *fumosa* (Wedd.) H. Olivier); Mayrhofer 1984 (map) – I, L

***Rinodina cretica*** H. Mayrhofer
Mayrhofer 1984 – I, L

***Rinodina dubyana*** (Hepp) J. Steiner
Mayrhofer 1984 (map) – L

***Rinodina exigua*** (Ach.) Gray
R (7 km S Anogia, 1993, leg. Nordin, UPS)

***Rinodina gennarii*** Bagl.
Syn. *Rinodina demissa* auct.
Zahlbruckner 1906; Szatala 1943b; Mayrhofer 1984 (map) – R, L

***Rinodina immersa*** (Körb.) Arnold
Syn. *Rinodina bischoffi* (Hepp) A. Massal. var. *immersa* Körb.
Zahlbruckner 1906; Szatala 1943b; Rondon 1969; Mayrhofer & Poelt 1979; Mayrhofer 1984 (map) – C (1 km S Imbros, leg. Mayrhofer & Ertl, GZU), I, L

***Rinodina lecanorina*** (A. Massal.) A. Massal.
Syn. *Rinodina ocellata* (Hoffm.) Arnold
Mayrhofer *et al.* 1990; Mayrhofer & Poelt 1979; Mayrhofer 1984 (map) – I, L

***Rinodina milvina*** (Wahlenb.) Th. Fr.
Szatala 1943b; Kleinig 1966; Mayrhofer 1984 (map) – I/R

***Rinodina obnascens*** (Nyl.) H. Olivier
I (Mate, 1997, leg. Grube, GZU).

***Rinodina pyrina*** (Ach.) Arnold
Szatala 1943b; Kleinig 1966 – C

***Rinodina sophodes*** (Ach.) A. Massal.
Kleinig 1966; Giralt & Mayrhofer 1995 – C

***Rinodina trachytica*** (A. Massal.) Bagl. & Carestia
Mayrhofer 1984 (map); Mayrhofer & Leuckert 1985; Mayrhofer & Poelt 1979; Mayrhofer *et al.* 1992 (map) – R

***Rinodina tunicata*** H. Mayrhofer & Poelt
Obermayer 1999; Helms *et al.* 2001 – C

***Rinodinella controversa*** (A. Massal.) H. Mayrhofer & Poelt
Syn. *Rinodina crustulata* (A. Massal.) Arnold
Szatala 1943b; Mayrhofer 1984 (map); Mayrhofer & Poelt 1978; Helms *et al.* 2001 – C, I

***Rinodinella dubyanoides*** (Hepp) H. Mayrhofer & Poelt
Mayrhofer & Poelt 1978; Mayrhofer 1984 (map) – I, C (1 km S Imbros, leg. Mayrhofer & Ertl, GZU)

***Roccella phycopsis*** Ach.
Syn. *Roccella fucoides* Vain.
Zahlbruckner 1904; Zahlbruckner 1906; Szatala 1943b; Kleinig 1966; Rondon 1969 – C, I, L

***Sagiolechia protuberans*** (Ach.) A. Massal.
Kleinig 1966 – L

***Sarcogyne privigna*** (Ach.) A. Massal.
C (3 km N Omalos, 1993, leg. Nordin, UPS), R (7 km S Anogia, 1993, leg. Nordin, UPS)

***Sarcogyne regularis*** Körb.
Syn. *Sarcogyne pruinosa* auct.
Steiner 1916; Szatala 1943b; Kleinig 1966 – C, R, I, L

***Solenopsora candicans*** (Dicks.) J. Steiner
Syn. *Placolecania candicans* (Dicks.) Zahlbr.
Zahlbruckner 1906; Szatala 1943b; Kleinig 1966; Rondon 1969 – C (road from Voukolies to Paleochora, 1998, leg. Rui & Timdal, hb Timdal), I, L

***Solenopsora cesatii*** (A. Massal.) Zahlbr.
Syn. *Placolecania cesatii* (A. Massal.) Zahlbr.; *Solenopsora bagliettoana* Tav. ined.; *Solenopsora cesatii* (A. Massal.) Zahlbr. var. *grisea* (Bagl.) Nimis
Zahlbruckner 1906; Szatala 1943b – C, R (14 km W Spili, 1993, leg. Nordin, UPS), I, L
The variety *grisea* is not distinguished, as intermediate forms links it with the type variety.

***Solenopsora marina*** ined.
C (road from Voukolies to Paleochora, 1998, leg. Rui & Timdal, hb. Timdal)

***Solenopsora olivacea*** (Fr.) H. Kilias
Syn. *Placodiella olivacea* (Fr.) Szatala; *Catillaria olivacea* (Fr.) Zahlbr.
Zahlbruckner 1906; Rondon 1969; Szatala 1943b; Roux 1991 (map) – C, R (14 km W Spili, 1993, leg. Nordin, UPS), I, L

***Solenopsora vulturiensis*** Bagl.
L (Karidi, 1976, leg. Mayrhofer, GZU)

***Squamarina cartilaginea*** (With.) P. James f. ***cartilaginea***
Syn. *Squamarina crassa* (Huds.) Poelt
Zahlbruckner 1906 (as *Lecanora*); Steiner 1916 (as *Lecanora*, f. *dealbata*); Szatala 1943b (var. *caespitosa* (Vill.) Rabenh., var. *liparia* (Ach.) Boistel); Kleinig 1966; Rondon 1969, Papp *et al.* 1999 – C, R, I, L

***Squamarina cartilaginea*** f. ***iberica*** (Mattick) Clauzade & Cl. Roux
Syn. *Squamarina crassa* f. *iberica* (Mattick) Poelt
Kleinig 1966 – C

***Squamarina concrescens*** (Müll. Arg.) Poelt
Rondon 1969; Poelt & Krüger 1970 (map); Papp *et al.* 1999 – C (Agios Nektarios, 1993, leg. A. Nordin, UPS), I (Ioúhtas, 1995, leg Rui & Timdal, hb. Timdal), R, L (4km N Mirtos, 1976, leg. Mayrhofer, GZU)

***Squamarina gypsacea*** (Sm.) Poelt
Syn. *Squamarina fragilis* (Scop.) Szatala
Kleinig 1966; Rondon 1969; Szatala 1943b; Papp *et al.* 1999 – C, I (Ioúhtas, 1995, leg Rui & Timdal, hb. Timdal), R, L (between Adravasti and Karidi, 1976, leg. Mayrhofer & Pölzl, GZU)

***Squamarina lentigera*** (Weber) Poelt
Syn. *Lecanora lentigera* (Weber) Ach.
Steiner 1916; Szatala 1943b; Poelt & Krüger 1970 (map); Papp *et al.* 1999 – C, R, I, L

***Squamarina oleosa*** (Zahlbr.) Poelt
Rondon 1969

***Staurothele fuscocuprea*** (Nyl.) Zschacke
Syn. *Staurothele clopima* (Wahlenb.) Th. Fr.
Szatala 1943b – R

***Staurothele hymenogonia*** (Nyl.) Th. Fr.
Syn. *Staurothele ventosa* (A. Massal.) P. Syd., *Staurothele extabescens* (Nyl.) Zahlbr.
Steiner 1916; Szatala 1943b – I, L
*Staurothele immersa* (A. Massal.) Dalla Torre & Sarnth.
Rondon 1969

***Stigmidium tabacinae*** (Arnold) Triebel
I (Matala, 1997, leg. Grube, GZU)
Host: *Toninia diffracta*

***Strigula affinis*** (A. Massal.) R.C. Harris
Syn. *Porina affinis* (A. Massal.) Zahlbr.
Szatala 1943b – C

***Synalissa symphorea*** (Ach.) Nyl.
Szatala 1943b – C

***Tephromela atra*** (Huds.) Hafellner var. ***atra***
Syn. *Lecanora atra* (Huds.) Ach.
Zahlbruckner 1906; Szatala 1943b; Kleinig 1966; Rondon 1969 (+ var. *discolor* (Duby) Schaer.) – R (1 km S Kouroutes, 1976, leg. Mayrhofer, GZU), R/I, I, L

***Tephromela atra*** (Huds.) Hafellner var. ***cypria*** (Körb.) Nimis
C (1 km S Imbros, leg. Mayrhofer & Ertl, GZU), I (Dia island, 1942, Rechinger, W; Nida plain, 1942, Rechinger, W), L (Street from Adravasti to Karidi, 1976, Mayrhofer & Pölzl, GZU)

***Thelenella modesta*** (Nyl.) Nyl.
Syn. *Microglaena modesta* (Nyl.) A.L. Sm.
Szatala 1943b; Mayrhofer & Poelt 1985; Mayrhofer 1987 – C

***Thelidium creticum*** J. Steiner
Steiner 1916; Szatala 1943b – I

***Thelopsis isiaca*** Stizenb.
Szatala 1943b; Vězda 1968 – C

***Toninia albilabra*** (Dufour) H. Olivier
Timdal 1991 (map) – C (between Vouklies and Kandanos, 1988, leg. Timdal, hb. Timdal)

***Toninia aromatica*** (Sm.) A. Massal.
Steiner 1916; Szatala 1943b; Kleinig 1966; Timdal 1991 (map) – C, R (2.5 km S of Koxare, 1988, leg. Timdal, hb. Timdal), I

***Toninia candida*** (Weber) Th. Fr.
Szatala 1943b; Rondon 1969; Timdal 1991 (map); Papp *et al.* 1999 – C (Agios Nektarios, 1993, leg. Nordin, UPS), R, I (hill just S of Fodele, 1988, leg. Timdal, hb. Timdal), L

***Toninia cinereovirens*** (Schaer.) A. Massal.
Timdal 1991 (map) – I (near Epanosifi Monastery, 1988, leg. Timdal, hb. Timdal)

***Toninia cretica*** Timdal
Timdal 1991 (map) – C (2 km N of Omalos, 1988, leg. Timdal, hb. Timdal), R (Psiloritis, 1988, leg. Timdal, hb. Timdal)

***Toninia diffracta*** (A. Massal.) Zahlbr.
C (Omalos, 1976, leg. Mayrhofer, GZU), R (Psiloritis, 1988, leg. Timdal, hb. Timdal), I (Matala, 1997, leg. Grube, GZU; filed under *Stigmidium tabacinae*)

***Toninia lutosa*** (Ach.) Timdal
C (Agios Nektarios, 1993, leg. Nordin, UPS)

***Toninia massata*** (Tuck.) Herre
Timdal 1991 (map) – I (Rogdia, 1965, leg. Degelius, UPS)

***Toninia opuntioides*** (Vill.) Timdal
Timdal 1991 (map) – C (Imbros, 1985, leg. Høiland, O), R (Psiloritis, 1988, leg. Timdal, hb. Timdal), L (Gournia, 1988, leg. Timdal, hb. Timdal)

***Toninia philippea*** (Mont.) Timdal
Syn. *Catillaria philippea* (Mont.) A. Massal.; *Catillaria lutosa* A. Massal.
Zahlbruckner 1906 – L
Not on Crete acc. to Timdal 1991 (maps)

***Toninia physaroides*** (Opiz) Zahlbr.
Timdal 1991 (map)

***Toninia sedifolia*** (Scop.) Timdal
Syn. *Toninia coeruleonigricans* Th. Fr.
Steiner 1916; Szatala 1943b; Kleinig 1966; Rondon 1969; Timdal 1991 (map); Papp *et al.* 1999 – C, R, I, L

***Toninia squalida*** (Ach.) A. Massal.
Syn. *Toninia acervulans* (Nyl.) Oliv.
Rondon 1969
Not mapped on Crete in Timdal (1991)

***Toninia taurica*** (Szatala) Oxner
Timdal 1991 (map) – C (ca. 2.5 km N of Omalos, 1998, leg. Rui & Timdal, hb. Timdal), R (Psiloritis, 1988, leg. Timdal, hb. Timdal)

***Toninia tristis*** (Th. Fr.) Th. Fr. ssp. ***tristis***
Timdal 1991 (map) – C (Agios Nektarios, 1993, leg. Nordin, UPS)

***Toninia tristis*** ssp. ***asiae-centralis*** (H. Magn.) Timdal
C (Imbros, 1988, leg. Timdal, hb. Timdal)

***Toninia tristis*** ssp. ***pseudotabacina*** Timdal
R (2 km E of Preveli Monastery, 1988, leg. Timdal, hb. Timdal), L (Gournia, 1988, leg. Timdal, hb. Timdal)

***Toninia tristis*** ssp. ***thalloedaemiformis*** (Szatala) Timdal
Syn. *Lecidea thalloedaeformis* Szatala
Szatala 1943b; Timdal 1991 – C (Imbros, 1988, leg. Timdal, hb. Timdal), R (Fourfouras, 1985, leg. Høiland, O), I (hill just S of Fodele, 1988, leg. Timdal, hb. Timdal), L

***Toninia tumidula*** (Sm.) Zahlbr.
C (1 km W of Kakopetros, 1988, leg Timdal, hb. Timdal), I (Iouhtas, 1995, leg. Timdal, hb. Timdal)

***Toninia verrucariae*** (Nyl.) Timdal
I (Kounari, leg. Nordin, 1993)
Host: *Bagliettoa parmigera*

***Topelia heterospora*** (Zahlbr.) P.M. Jørg. & Vězda
Syn. *Clathroporina heterospora* Zahlbr.
Szatala 1943b; Vězda 1968 – I

***Tornabea scutellifera*** (With.) J. R. Laundon
I (Iouhtas, 1995, Rui & Timdal, O)

***Trapelia obtegens*** (Th. Fr.) Hertel
Syn. *Lecidea obtegens* (Th. Fr.) Vain.
Szatala 1943b – L

***Usnea articulata*** (L.) Hoffm.
Szatala 1943a (ssp. *mediterranea* Motyka) – C

***Usnea filipendula*** Stirt.
Syn. *Usnea dasypoga* auct.
Kleinig 1966 – C

***Verrucaria acrotella*** Ach.
Kleinig 1966 – L

***Verrucaria adriatica*** Zahlbr.
Szatala 1943b – L

***Verrucaria attica*** J. Steiner
Steiner 1916, Kleinig 1966 – I

***Verrucaria aspiciliicola*** R. Sant.
Syn. *Verrucaria. aspiciliae* Zehetl.
Zehetleitner 1978 – L
Host: *Aspicilia calcarea*

***Verrucaria caerulea*** DC.
Syn. *Verrucaria plumbea* Ach., *Involucrothele plumbea* (Ach.) Servít
Kleinig 1966 – C

***Verrucaria cyanea*** A. Massal.
Syn. *Verrucaria decussata* Garov.
Zahlbruckner 1906 – I

***Verrucaria foveolata*** (Flörke) A. Massal.
Syn. *Verrucaria dolomiticola* (A. Massal.) Kremp.
Rondon 1969 – C (Agios Nektarios, 1993, leg. Nordin, UPS)

***Verrucaria fuscella*** (Turner) Winch
Zahlbruckner 1906 – L

***Verrucaria fuscula*** Nyl.
Syn. *Dermatocarpon insulare* (A. Massal.) Mig.
Rondon 1969

***Verrucaria hochstetteri*** Fr. var. ***mastoidea*** (A. Massal.) Clauzade & Cl. Roux
Syn. *Amphoridium mastoideum* A. Massal.
Steiner 1916 – I

***Verrucaria macrostoma*** Dufour ex DC.
Steiner 1916; Kleinig 1966; Rondon 1969 – I

***Verrucaria marmorea*** (Scop.) Arnold
Syn. *Amphoridium marmoreum* (Scop.) Baroni
Zahlbruckner 1906; Kleinig 1966; Rondon 1969 – C, L

***Verrucaria mortarii*** Lamy
Rondon 1969

***Verrucaria muralis*** Ach.
Syn. *Verrucaria rupestris* Schrad. non (Scop.) Weber ex. F.H. Wigg.
Zahlbruckner 1906; Steiner 1916 (var. *hypophaea* Steiner & Zahlbr.); Rondon 1969 – I, L

***Verrucaria murina*** Leight.
Steiner 1916 – I

***Verrucaria nigrescens*** Pers.
Szatala 1943b; Rondon 1969 – C, I (2 km W Festos, 1993, leg. Nordin, UPS), L
***Verrucaria ruderum*** DC.
Rondon 1969

***Xanthoparmelia conspersa*** (Ehrh. ex Ach.) Hale
Syn. *Parmelia conspersa* (Ach.) Ach., *Parmelia isidiata* (Anzi) Gyeln.
Szatala 1943b; Kleinig 1966 – I
***Xanthoparmelia somloensis*** (Gyeln.) Hale
Syn. *Parmelia somloensis* Gyeln.; *Parmelia stenophylla* (Ach.) auct.
Rondon 1969
***Xanthoparmelia tinctina*** (Maheu et Gillet) Hale
Papp *et al.* 1999 – C
***Xanthoparmelia verrucigera*** (Nyl.) Hale
Syn. *Parmelia conspersa* var. *verrucigera* (Nyl.) Boistel; *Parmelia verrucigera* Nyl.
Steiner 1916 – I
***Xanthoria calcicola*** Oxner
Syn. *Xanthoria aureola* (Ach.) Erichsen
Kleinig 1966; Rondon 1969 (+ var. *ectanea* (Ach.) Kickx.) – C, R (6 km Se Nea Kria Vrisi, leg. Mayrhofer & Ertl, GZU; 2 km W Festos, 1993, leg. Nordin, UPS), L
***Xanthoria mediterranea*** Giralt, Poelt & Nimis
Syn. *Xanthoria isidioidea* auct. pro parte
Kleinig 1966; Giralt *et al.* 1993 – C, I
***Xanthoria parietina*** (L.) Th. Fr.
Zahlbruckner 1906 (+ var. *retirugosa* J. Steiner); Kleinig 1966 – C (Omalos, 1976, leg. Mayrhofer, GZU), I

***Zwackhiomyces inconspicuus*** Grube & Hafellner
Grube & Hafellner 1990 – R/I
Host: *Lecanora dispersa.*

**Unclear taxa**

***Aspicilia bricconensis*** Hue
Rondon 1969
A dubious taxon, which might refer to Dirina.
***Aspicilia lactea*** A. Massal.
Kleinig 1966 – R
Clauzade & Roux 1985 list this taxon under *Lecania erysibe* (Ach.) Mudd.
***Aspicilia reticulata*** Kremp.
Steiner 1916 (var. *contortoides*); Szatala 1943b (+ *ammotropha* (Hue) Szatala) – R/I, I, L
*Aspicilia r. ammotropha* is a synonym of *Aspicilia intermutans* (Nyl.) Arnold

***Collema sublimosa*** J. Steiner
Steiner 1916 – I
Probably a member of the C. *tenax group.* See Degelius 1954: 461 (material not seen)
***Lecanora coerulata*** (Ach.) Szatala
Szatala 1943b – I, L
***Lecidea ocellulata*** (Schaer.) Th. Fr.
Szatala 1943b – I
This taxon could belong to *Lecidea fuscoatra* (L.) Ach.

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# *STUDIA LICHENOLOGICA* IN ITALIA CENTRALE. III. SPECIE NUOVE PER L'UMBRIA

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**Keywords:** Central Italy, Flora, Lichens, Umbria.

**Abstract:** *Studia Lichenologica* in Central Italy. III. Species new to Umbria. 31 infrageneric *taxa* are reported as new to the lichen flora of Umbria (Central Italy). Notes concerning their ecology and distribution are given. The new combination *Phaeocalicium mildeanum* (Hepp) Puntillo is proposed.

## Introduzione

Per contribuire alle conoscenze lichenologiche dell'Italia centrale, ancora poco esplorata, gli autori stanno effettuando da alcuni anni ricerche di tipo floristico e fitogeografico nell'Umbria centro-meridionale. Questo territorio, nonostante la posizione baricentrica rispetto al resto d'Italia, ha condiviso il destino delle regioni adriatiche, poco studiate perché lontane dai principali istituti botanici (Nimis & Tretiach, 1999). Nella prima stesura della checklist dei licheni d'Italia (Nimis, 1993) venivano attribuite all'Umbria solamente 47 segnalazioni, 39 delle quali riferite al Duomo d'Orvieto (Nimis & Monte, 1988). Una sistematica esplorazione del territorio (Ravera, 1998; 1999; 2000a; 2000b; Nimis & Tretiach, 1999; Panfili, 2000a, 2000b; Genovesi & Ravera, 2001) ha in seguito portato a 415 il numero di *taxa* noti.

In questo lavoro si segnalano 31 nuove specie per la regione, con qualche commento di interesse lichenologico, ecologico, fitogeografico su ogni entità.

## Area di studio

L'Umbria è una regione in prevalenza collinare e montuosa: il clima varia dalla continentalità delle zone altomontane alle condizioni miti, di tipo mediterraneo, dei settori collinari (Orsomando *et al.*, 1999).

Le litologie affioranti che interessano le località di raccolta (v. oltre), sono riunite nel complesso carbonatico formato da rocce di origine calcarea che attualmente costituiscono l'ossatura di tutti i rilievi umbri (C.R.I.D.E.A., 1999).

Il paesaggio vegetale delle fasce medio-alte collinari è rappresentato da boschi a sclerofille sempreverdi e dai querceti submediterranei che, sui versanti più favorevoli, si spingono fino a c. 1.100 m s.l.m.. La fascia montana è ricoperta dai boschi di faggio, monospecifici o misti ad *Acer* sp. pl. e *Sorbus aria*, talvolta con potenzialità per *Abies alba*. Nei fondovalle sono frequenti i consorzi mesofili a *Carpinus betulus* e *Corylus avellana* e le boscaglie ripariali a ontani *Alnus glutinosa* e *Salix* sp. pl., miste a pioppi ibridi e robinie. Di notevole interesse lichenologico sono i vecchi impianti di castagno la cui distribuzione, date le caratteristiche del substrato e la parassitosi che li ha colpiti, è molto ridotta.

## Dati e metodi

Per la determinazione delle specie sono stati consultati Clauzade & Roux (1985), Fryday & Coppins (1997), Puntillo (1989), Purvis *et al.* (1992), Timdal (1991), Vitikainen (1994), Wirth (1995).

La nomenclatura delle specie segue Nimis (2000), quella delle fanerogame Pignatti (1982), l'abbreviazione degli autori Brummitt & Powell (1992).

Le valutazioni di rarità, rischio di estinzione, la distribuzione fitogeografica e le caratteristiche ecologiche sono desunte da Nimis (1993, 2000); l'appartenenza sintassonomica da Wirth (1995).

Di ogni specie sono indicati: luogo del ritrovamento, tipo di substrato, altitudine, data, e l'iniziale del cognome del raccoglitore (V. Genovesi = G, G.

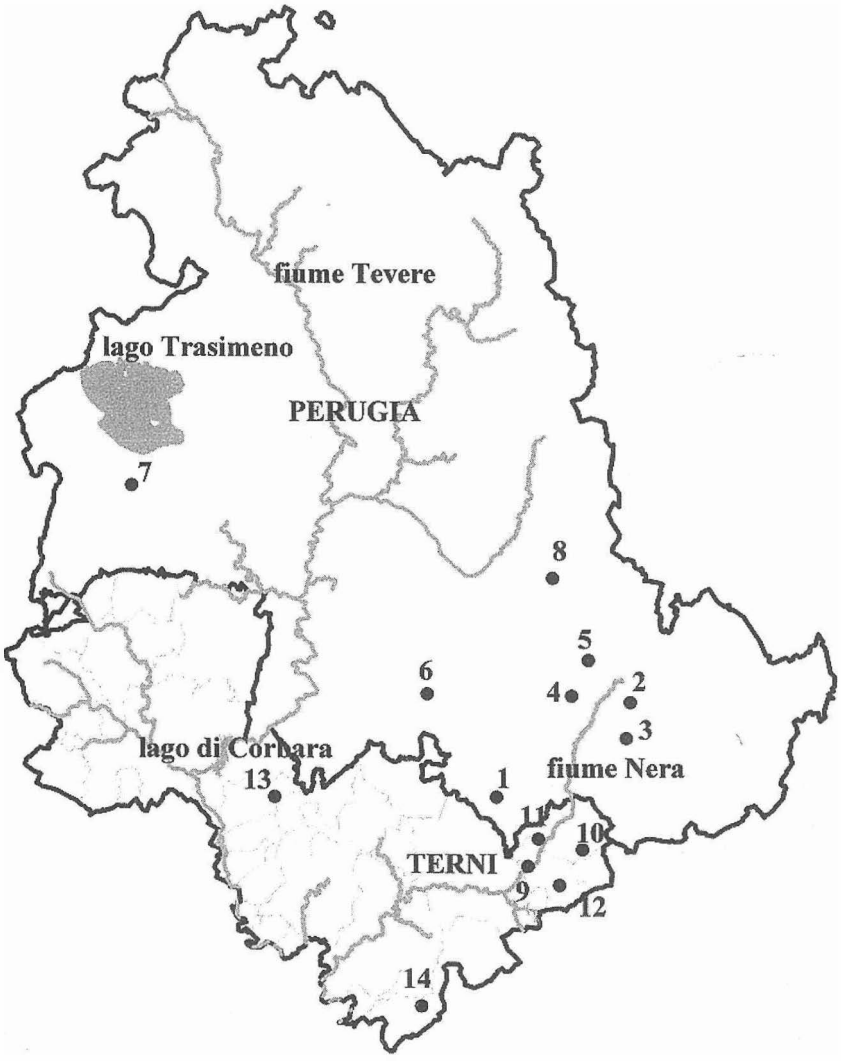


Fig. 1. - Mappa schematica dell'Umbria con l'indicazione delle località in cui sono stati raccolti i licheni, numerate come nel testo
*Survey area with geographic distribution of sampling stations, numbered as in the text.*

Massari = M, D. Puntillo = P, S. Ravera = R).

I campioni sono conservati nell'Erbario del Dipartimento di Biologia Vegetale dell'Università di Roma "La Sapienza" (RO), presso l'Orto Botanico.

Le località di raccolta (Fig. 1) sono indicate con il nome del rilievo o del centro abitato più vicino. L'asterisco (*) evidenzia i biotopi di rilevante interesse vegetazionale meritevoli di conservazione, segnalati dalla Società Botanica Italiana (1971, 1979).

Provincia di Perugia: 1) Montebibico, a pochi chilometri dal centro abitato. Vecchio castagneto da frutto a contatto con un bosco a *Carpinus betulus* e *Corylus avellana*, 860 m s.l.m., 2/10/00, leg. GMPR. 2)* M.te Coscerno, sopra Forca della Spina. Seslerieti con rocce affioranti, calcare bianco e bianco avorio, 1.400-1.600 m s.l.m., 2/5/99, leg. GMR. 3)* M.te Eremita, lungo il sentiero da Gavelli. In faggeta, calcari grigiastri e plumbei o nocciola, 1.120 m s.l.m., 1/5/99, leg. GMR. 4) M.te Galenne, dintorni del Casale dei Cappuccini, in cerreta, rocce affioranti, calcare bianco e bianco avorio, compatto e ben stratificato con lenti o strati di selce, ca. 1.000 m s.l.m., 28/4/00, leg. GMR. 5) M.te Serano, marne mandorlate rosse e verdi, alternate a calcari rossi, 1.100-1.200 m s.l.m., 8/4/00, leg. G. 6)* M.ti Martani, Parco Regionale. Monte Martano e Monte Castro, margini di faggeta. Scaglia rossa e calcare bianco e bianco avorio, compatto e ben stratificato con lenti o strati di selce, 800-930 m s.l.m., 1/5/00, leg. GMR. 7)* Panicale. Bosco di roverella di

Panicarola, ca. 300 m s.l.m., 28/10/98, leg. R. 8)* Sassovivo. Nei pressi della sorgente minerale, marne rosse e verdastre in alternanza con calcari di colore verde chiaro, ca. 600 m s.l.m., 27/4/00, leg. GMR.

Provincia di Terni: 9) Ferentillo, lungo il Fosso d'Ancaiano, su *Fraxinus ornus*, 325 m s.l.m., 6/10/00, leg. GMPR. 10) M.te Petano, pressi di Salto del Fosso e Dogana. Pareti fortemente inclinate o verticali. Scaglia rossa, ca. 900 m s.l.m., 3-4/10/00, leg. GMPR. 11)* M.te Solenne, pressi di Loreno, su affioramenti di calcari marnosi rossi e bianchi con selce grigia in lenti ed arnioni ed intercalazioni di calcari detritici, 825 m s.l.m., 14/2/00, leg. GMR. 12) M.te La Pelosa, margini di faggeta, calcari grigi e grigi scuri, ben stratificati, ca. 1.300 m s.l.m., 5/3/00, leg. G. 13) Melezzole, in castagneto, scaglia rossa, ca. 700 m s.l.m., 6/10/00, leg. GMPR. 14) M.te San Pancrazio, radure ai margini di lecceta, rocce affioranti di calcare massiccio, ca. 1.000 m s.l.m., 15/7/00, leg. G.

**Risultati**

***Agonimia tristicula*** (Nyl.) Zahlbr.

Tipicamente su muschi terricoli, si trova alla base di vecchi alberi, anche nel *Lobarion*. La sua presenza in Italia è apparentemente sottostimata. (10), su muschio.

***Arthonia cinnabarina*** (DC.) Wallr.

Poco comune nel nostro Paese, in via di estinzione. Si conferma l'affinità per la scorza liscia di *Fraxinus*, all'interno di boschi umidi. Caratteristica dell'*Opegraphetum rufescens* Almb. 1948 ex Klem. 1955. (9).

***Arthonia pruinata*** (Pers.) A. L. Sm.

Poco comune e in declino, è ristretta ad ambienti umidi ed ha affinità tirrenica. Tipica di vecchi alberi isolati, in nicchie protette dalla pioggia. Caratterizza l'*Arthonietum pruinatae* Almb. 1948. (10), su radice.

***Aspicilia parasitica*** de Lesd.

Poco comune in Italia. Xerofitica, cresce prevalentemente su licheni crostosi silicicoli che colonizzano superfici esposte e fortemente inclinate. (6), parassita su *Aspicilia calcarea* (L.) Mudd.

***Bacidia bagliettoana*** (A. Massal. & De Not.) Jatta

È localmente comune nelle regioni alpina, subalpina e sulle montagne mediterranee; si trova tipicamente su muschio, in fessure di roccia calcarea, dove è stata raccolta. (11, 12).

***Calicium adspersum*** Pers.

Molto raro, proprio di conifere e vecchi alberi decidui con scorza acida e profondamente fessurata, in nicchie protette dalla pioggia. L'unica segnalazione per l'Italia centrale riguarda la Toscana (Jatta, 1909-11). Caratteristica del *Chrysotrichetum candelaris* Mattick 1937 ex Barkm. 1958. (1), su legno di *Castanea sativa.*

***Caloplaca cerina*** var. ***chloroleuca*** (Sm.) Th. Fr.

Tipicamente sopra la linea degli alberi, nell'area di studio si trova su substrato calcareo nell'ambito di seslerieti a *Sesleria nitida* e *S. apennina.* (2, 12), su muschio.

***Caloplaca flavovirescens*** (Wulfen) Dalla Torre & Sarnth.

Tipica di silicati basici e arenarie, più raramente su calcari compatti. Si segnala dal Monte Galenne, su substrato calcareo. (4, 5).

***Catapyrenium cinereum*** (Pers.) Körb.

Specie rara, localmente comune solo nella fascia subalpina, al suolo. (2).

***Catapyrenium imbricatum*** (Nyl.) Clauzade & Cl. Roux

Rara, tipica di roccia e suoli calcarei. Segnalata da Sommier (1910) e Jatta (1909-11) per la Toscana e da Nimis & Tretiach (1993) per la Sardegna. (2), al suolo.

***Catapyrenium rufescens*** (Ach.) Breufl

Specie rara in Italia, xerofitica, calcicola. (14), al suolo.

***Chaenotheca ferruginea*** (Sm.) Migula

Specie molto rara, propria di scorza e legno di conifere e vecchi alberi decidui, in situazioni umide e ben illuminate ma protette dalla pioggia. Caratteristica del *Chaenothecetum ferrugineae* Barkm. 1958, è tra le specie segnalate nella Lista Rossa dei licheni d'Italia (Nimis, 2000). (1), su legno di *Castanea sativa.*

***Chaenotheca furfuracea*** (L.) Tibell

Igrofitica, tipica di radici affioranti o nicchie protette dalla pioggia in situazioni umide. È stata raccolta su radice di *Corylus avellana* nell'ambito del *Carpino betuli-Coryletum avellanae* Ballelli, Biondi & Pedrotti 1980. Caratterizza il *Chaenothecetum furfuraceae* Kalb. 1969. (1).

***Chaenotheca trichialis*** (Ach.) Th.Fr.

Poco comune, acidofila, igrofitica, più frequente sulle Alpi. (1), su legno di *Castanea sativa.*

***Fulgensia fulgens*** (Sw.) Elenkin

Specie epigea, tipica di suolo calcareo e praterie aride, è stata raccolta al limite di una cerreta. Caratteristica del *Toninio-psoretum decipientis* Stodieck 1937. (10).

***Lecanora epibryon*** (Ach.) Ach.
Specie epibriofitica a distribuzione circumboreale (-polare) artico-alpina, lungo l'Appennino nota solo per le vette abruzzesi più elevate (Grillo & Romano, 1987; Nimis & Tretiach, 1999). Nell'area di studio è stata raccolta sul versante del rilievo dove è segnalata la presenza di *Vaccinium myrtillus* (Francalancia & Orsomando, 1981). (2).

***Lecanora sambuci*** (Pers.) Nyl.
Poco comune in Italia, generalmente su sambuco (*Sambucus nigra*) e pioppo (*Populus* sp.), non si osserva in ambienti fortemente antropizzati. Caratteristica del *Lecanoretum sambuci* Wirth 1980. (10, 7), su scorza di *Sambucus nigra*.

***Lepraria nivalis*** J.R. Laundon
Lichene tipico di calcari e dolomie, su superfici molto inclinate e protette dalle precipitazioni dirette. I campioni sono stati analizzati mediante cromatografia su lastra sottile presso l'Università di Trieste (supervisione: Prof. C. Leukert, Berlin), rilevando la presenza di acido protocetrarico. (10, 8).

***Leptogium gelatinosum*** (With.) J.R. Laundon
Più acidofilo dell'affine *Leptogium lichenoides* (L.) Zahlbr. (6), su suolo e muschi.

***Megaspora verrucosa*** (Ach.) Hafellner & V. Wirth var. ***verrucosa***
Epibriofitica, a distribuzione circumboreale-montana (-alpina), rara lungo gli Appennini. Nella stessa stazione di *Lecanora epibryon*. Caratterizza il *Megasporion verrucosae* Kalb 1970. (2).

***Microcalicium arenarium*** (A. Massal.) Tibell
Rara, si tratta della prima segnalazione per l'Italia centrale. Tipicamente parassita *Psilolechia lucida* (Ach.) M. Choisy o popolazioni di *Stichococcus* e *Cystococcaceae* ma si riscontra anche su radici esposte e su legno in situazioni umide ed ombrose. Nella stazione è stata raccolta su radici esposte in una nicchia del suolo. Caratteristica dello *Psilolechietum lucidae* Schade 1934 ex Klem. 1950, è tra le specie segnalate nella Lista Rossa dei licheni d'Italia (Nimis, 2000). (1).

***Parmelia somloensis*** Gyelnik
Propria di roccia silicea e silicati basici, si segnala su suolo calcareo. Caratterizza il *Parmelietum somloensis* Klem. 1955. (12).

***Peltigera neckeri*** Müll. Arg.
Più comune in faggeta. In ambienti umidi colonizza direttamente il suolo, come nel caso delle stazioni umbre. (6, 10).

***Peltigera polydactyla*** (Neck.) Hoffm.
Localmente comune nella regione montana, raccolta su suolo e muschio. (3).

***Phaeocalicium mildeanum*** (Hepp) Puntillo comb. nov. hoc loco
Basionimo: *Calicium mildeanum* Hepp apud Rabenh., Lichen. Eur., nr. 718, 1864.
Sinonimi: *Stenocybe mildeana* (Hepp) Jatta in Sylloge Lich. Ital., 1900: 478; *Calicium ornicolum* Stein. apud Zahlbr. in Ann. Naturhist. Hofmus. Wien 25 (1911): 239; *Mycocalicium ornicolum* (Steiner) Nádv.; *Mycocalicium mildeanum* (Hepp) Nádv.
La specie è da attribuire al genere *Phaeocalicium* A. Schmidt poiché possiede spore ellissoidali 1(3) settate e non fusiformi plurisettate, come tipico del genere *Stenocybe* (Nyl.) Körb. Inoltre è molto vicino a *Phaeocalicium populneum* (Brond. ex Duby) A. Schmidt da cui differisce per le spore più grandi (13-29 x 7-9 μm). Estremamente rara e in declino, è nota esclusivamente per il Trentino-Alto Adige (Arnold, 1869; Dalla Torre & Sarnthein, 1905) e per le Marche (Nimis & Tretiach, 1999) su *Fraxinus*. Si conferma l'affinità di questa specie per *Fraxinus ornus* e per gli ambienti umidi. È tra le specie segnalate nella Lista Rossa dei licheni d'Italia (Nimis, 2000). (10).

***Rhizocarpon obscuratum*** (Ach.) A. Massal.
Specie silicicola e pioniera, morfologicamente e chimicamente variabile. (13).

***Sarcogyne fallax*** H. Magn.
Rara, è nota in Italia per l'Emilia-Romagna (Magnusson, 1935-1936), la Toscana (Coppins in Nimis, 1993; Tretiach & Nimis, 1994) e l'Abruzzo (Nimis & Tretiach, 1999). Tipica di rocce intermedie, quali arenarie e scisti calcarei, in boschi decidui aperti. (10).

***Sarcogyne privigna*** (Ach.) A. Massal.
Poco comune in Italia; pioniera. Raccolta su scaglia rossa. Secondo Nimis & Tretiach (1999), la var. *calcicola*, diffusa nel versante adriatico della Penisola e nell'Italia meridionale, ha scarso valore tassonomico. (13).

***Staurothele hymenogonia*** (Nyl.) Th. Fr.
Poco comune in Italia. Specie pioniera, in Umbria si segnala su rocce calcaree affioranti. (2, 5).

***Toninia opuntioides*** (Vill.) Timdal
Poco comune in Italia. (6, 10, 11, 12).

***Trapelia coarctata*** (Sm.) M. Choisy
Rara, silicicola e prevalentemente tirrenica. Caratterizza il *Porpidietum crustulatae* Klem. 1950. (12, 13), su selce.

## Discussione

Il continuo aumento in questi ultimi anni del numero delle specie riportate per l'Umbria sembra confermare la presenza di condizioni adatte per lo sviluppo di una flora lichenica ricca e diversificata. La prevalenza delle montagne, la bassa densità della popolazione, l'assenza di importanti insediamenti industriali (con qualche eccezione, come la Conca ternana) hanno limitato la concentrazione e la diffusione degli agenti inquinanti (Marchetti *et al.*, 1999; Bargagli *et al.*, 2000), con evidente vantaggio per la conservazione della diversità lichenica.

Le nuove segnalazioni offrono lo spunto per alcune considerazioni. Per quanto riguarda i licheni epifiti, *Calicium adspersum, Chaenotheca ferruginea, Ch. trichialis, Microcalicium arenarium* fanno parte del corteggio floristico dei castagneti. La scorza subacida e profondamente fessurata degli esemplari più vetusti di *Castanea* è un habitat ideale per le *Caliciales*: si formano nicchie protette dall'azione diretta delle precipitazioni, in ambienti con umidità atmosferica piuttosto elevata e luce diffusa. La presenza delle *Caliciales* è indicatrice di continuità ecologica e conferma l'importanza dei castagneti la cui conservazione, non soltanto per motivi lichenologici, deve essere fortemente sollecitata.

Un altro punto riguarda i licheni epilitici di substrati intermedi (quali *Aspicilia parasitica, Caloplaca flavovirescens, Parmelia somloensis*, ecc.) che in Umbria si trovano con una certa frequenza anche su calcari duri e compatti. Questo fenomeno, già segnalato per l'Italia adriatica e certamente legato all'influenza di fattori climatici (Nimis & Tretiach, 1999), deve essere ancora correttamente interpretato (Salvadori & Tretiach, 2001).

**Riassunto**

In questo contributo alla conoscenza della flora lichenica dell'Italia centrale sono riportate 31 specie nuove per l'Umbria e viene proposta la nuova combinazione *Phaeocalicium mildeanum* (Hepp) Puntillo. Alla luce delle nuove segnalazioni, alcune delle quali d'interesse ecologico e fitogeografico, si rileva: 1) l'importanza della salvaguardia dei castagni pluricentenari, che costituiscono il substrato d'elezione per molte specie di *Caliciales*; 2) il rinvenimento su substrati calcarei di alcune specie silicicole, analogamente a quanto osservato in altri distretti appenninici.

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